Theory of Planned Behaviour, Participation, and Physical Activity Communication in the Workplace

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ABSTRACT

Introduction: Promoting health and physical activity in the workplace is advocated by public health institutions across the globe. There is a need to find effective ways to understand the determinants of participation in physical activity in order to outline appropriate communication strategies to promote physical activity behaviour change in the workplace setting. E-mails and text messages show great potential to reach a captive audience at minimal costs, but little is known on their effects on physical activity behaviour. Moreover, few studies have investigated employees' reasons for participating in workplace physical activity interventions.

Aims: This dissertation had three main objectives. The first was to test the predictive utility of the Theory of Planned Behaviour (TPB) in the context of a theory-based workplace physical activity communication intervention (the MoveM8 programme) promoting participation in leisure-time (LTPA) and work-related physical activity (WPA) through e-mails and SMS text messages. The second objective was to test the effect of the MoveM8 programme on TPB constructs (i.e., attitudes towards the behaviour, subjective norms, perceived behavioural control and behavioural intention), and on behaviour. The third objective was to examine employees' reasons for participating and not participating in the MoveM8 programme, in order to provide a deeper understanding of what motivates employees to sign up for a workplace physical activity promotion intervention.

Methods: To fulfil these objectives, both quantitative and qualitative methods were used. The first two objectives were achieved through the use of quantitative data collected through pre- and post- intervention surveys. The third objective was pursued using the analysis of interviews and focus groups conducted with employees who participated and who did not participate in the MoveM8 programme. The first two aims were investigated using structural equation modelling (SEM) techniques. The third aim was investigated using thematic analysis.

Results: Results from SEM analyses provided evidence to support the capability of the Theory of Planned Behaviour in identifying the social-cognitive determinants of physical activity and predicting behaviour (total physical activity and LTPA, but not WPA). Perceived behavioural control was the strongest predictor of behavioural intention across all models ($\beta \approx .75$, $p > .001$). Intention significantly predicted LTPA ($\beta = .32$, $p > .001$) and total physical activity ($\beta = .34$, $p > .001$) at 12 weeks (Time 1) and 16 weeks (Time 2) after the start of the intervention. Data also showed some significant, albeit small, intervention effects on attitudes across behaviours, and a small significant effect on WPA at Time 1, associated with the use of e-mails instead of the combined use of e-mail and text messages. Qualitative thematic analysis of interviews and focus groups revealed that the major reasons for participating in the MoveM8 programme were related to personal motives (e.g., the need to better manage weight), and to perceived positive characteristics of the intervention itself (associated with a curiosity towards a novel technology-based intervention and to the use of reminders), and to the role of employer in endorsing and recommending the programme. The major reasons for non-participation were related to lack of time, feeling that the programme was not relevant to them, lack of confidence with technology, and lack of follow-up with the promotion of the intervention, which was related to a limited support by the employer.

Conclusions: The Theory of Planned Behaviour is useful to predict physical activity behaviour among employees. Future studies should use this theory to design, assess, evaluate and predict physical activity behaviour and its socio-cognitive determinants. This study confirmed the important role of technology-based reminders, in particular e-mails, as cues to action for promoting and maintaining physical activity in the workplace. Participation in a technology-based workplace physical activity communication programme is influenced by aspects related to individual's needs and motivations to become more active, characteristics of the programme itself, and organisational support. To maximise participation, future studies should stress the importance of perceived benefits, involve organisations and employees in the design and creation of programmes, and facilitate access to these programmes by providing tangible incentives and continuous support so that larger segments of the population are reached.

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1.1 Introduction to the study

There is an established international consensus regarding the numerous benefits of physical activity on physical, social and mental health, as well as on the economy of organisations and systems. The evidence collected in more than 60 years of epidemiological research shows that regular physical activity is associated with reduced risk of cardiovascular diseases (CVD), coronary hearth diseases (CHD), chronic respiratory diseases, diabetes and metabolic syndrome, various cancers and other obesity-related conditions (CDC, 2001, 2010; OECD, 2010; WHO, 2009, 2011). It is also associated with strengthening bones and muscles, improving mental health and mood, and increasing the chances of a longer life (CDC, 2010). In other terms, insufficient physical activity or physical inactivity is considered the fourth leading health risk factor of noncommunicable diseases (NCDs), after tobacco use, unhealthy diet, and harmful use of alcohol (WHO, 2009, 2011). Physical inactivity is also a critical public health issue because of its direct and indirect impact on a nation's economy through increased healthcare costs.

While various health and economic benefits of physical activity are well known and continuously supported by new scientific evidence, in the last century the levels of physical activity have decreased worldwide. The World Health Organisation's global reports show that in all regions the prevalence of insufficient physical activity is high (WHO, 2011). In Europe, two thirds of the adult population (aged 15 years and over) are inactive or do not reach the recommended levels of activity (Cavill, Kahlmeier, & Racioppi, 2006).

In order to prevent the onset of noncommunicable diseases and reduce their health burden on future generations, influential health organisations, such as the World Health Organisation (WHO) and the U.S. Centres for Disease Control & Prevention (CDC), developed several strategies and action plans (Pratt, Epping, & Dietz, 2009; USDHHS, 2011; Waxman, 2004, 2005; WHO, 2000, 2004, 2009). The scope of these strategies and action plans is to support and coordinate governments and organisations in their efforts to develop programmes or initiatives to encourage physical activity in different settings (e.g., schools, workplaces, communities, etc.) and among various segments of the population. In achieving these objectives, communication plays a crucial role, first because strategies need to be communicated to the different stakeholders, and second because initiatives need to be publicised and promoted to the end-users or target audiences.

Considering that the 60% of the world's population is accessible directly or indirectly through the workplace, and that most of our waking hours are spent in the workplace, workplaces are considered a promising setting for health communication initiatives (Batt, 2009; Blake & Lloyd, 2008). Physical activity promotion in the workplace is a priority in many countries throughout the world, has been advocated by key government policies, and endorsed by international, national and local authorities. In the case of United Kingdom, workplaces are recognised as a key strategic setting for health promotion and for physical activity promotion (DH, 2004, 2005; DH & DWP, 2005).

Among the strategies to promote physical activity, technology-based interventions offer great potential for health promotion in general and specifically for health promotion in the workplace (Bennett & Glasgow, 2009; Pelletier, 2009). E-mail and mobile phones are often utilised in health behaviour change interventions, and there is some evidence about their effectiveness in influencing end-users' adoption and maintenance of behaviours (e.g., Block, Block, Wakimoto, & Block, 2004; Fjeldsoe, Marshall, & Miller, 2009; Plotnikoff, McCargar, Wilson, & Loucaides, 2005; van Wier et al., 2011), or in disease management and prevention (e.g., Cole-Lewis & Kershaw, 2010; Krishna, Boren, & Balas, 2009). However, there is little evidence on the usage of these technologies in worksite physical activity promotion interventions.

Thus, in response to policy requirements, public health need and research gaps the MoveM8 research project was developed and conducted. An integral part of the research project was the "*MoveM8 programme*", a 12-week e-mail and text messaging (SMS) physical activity communication RCT promoting leisure-time (LTPA) and workplace physical activity (WPA) among employees of organisations situated in the United Kingdom. The MoveM8 intervention, whose design was based on the Theory of Planned Behaviour, built upon the work of Plotnikoff and colleagues (Plotnikoff et al., 2005) by testing the added value of an SMS component to a weekly e-mail communication. The MoveM8 intervention was conducted between September 2009 and August 2010.

Additionally, to investigate the reasons for participation and non-participation in the MoveM8 programme, a qualitative investigation, using interviews and focus groups, was conducted between June and July 2011. Interviews examined more in depth individual characteristics that might have impacted participation (e.g., personal preferences towards technology, attitudes about the personal benefits of being physically active, past experiences with physical activity, etc.).

1.2 Aims and objectives of this dissertation

This dissertation builds upon some of the findings of the MoveM8 project and reports data extracted from the quantitative and qualitative studies. This dissertation had three main objectives: the first was to test the Theory of Planned Behaviour (Ajzen, 1991) and investigate its predictive utility of physical activity behaviour in a workplace setting; the second was to test the effects of the MoveM8 programme on TPB constructs (i.e., attitudes towards the behaviour, subjective norms, perceived behavioural control and behavioural intention), and on physical activity behaviour; the third was to examine employees' reasons for participating and not participating in the MoveM8 programme.

1.3 Motivation and relevance

The results of this study bring insight on the effects of information and communication technologies (specifically text messaging and e-mail communication) in maintaining or increasing physical activity behaviour in a workplace setting. From a public health perspective, these technologies represent a low-cost solution to the stringent problem of insufficient and inadequate levels of physical activity. In addition to understanding if the use of new technologies can effectively assist behaviour change (or maintenance), it is important to understand the behavioural determinants of physical activity in order to better develop adapted, efficacious and accurate behaviour change programmes. To this extent, this study tested and applied the Theory of Planned Behaviour (TPB), which offers a framework to describe the socio-cognitive determinants of physical activity behaviour, to a sample of employees. The TPB postulates that attitudes, subjective norms, and perceived behavioural control are the predictors of behavioural intention, which is, in turn, a predictor of behaviour.

Furthermore, it is important to understand why people participate and do not participate in workplace health interventions, because increasing or maintaining high participation rates is one of the crucial problems in public health interventions in general, and in workplace health promotion in particular. Understanding what drives some people and what discourages some others to enrol in these programmes is crucial for the development and implementation of more appropriate strategies, which can better respond to people's needs and interests, and hence become more effective.

This dissertation has both scientific and practical utility. From a scientific point of view, this work provides an important contribution and suggestions for the development of future studies in the field of health communication initiatives. It also furthers the knowledge of the Theory of Planned Behaviour and extends its application to a population of employees. The analysis of TPB models provided in this dissertation allows to further the understanding of socio-cognitive determinants that significantly predict actual behaviour among employees. From a public health perspective, this understanding allows to identify strategies that could help increase the reach of these programmes so that their positive effects could expand from individuals to organisations and society at large.

1.4 Structure of the dissertation

This dissertation is structured in five chapters. Chapter Two describes the background and rationale of this work by presenting a literature review of current trends and research about three main topical areas: first, workplace health promotion, with a focus on physical activity promotion; second, e-Health and technology-based interventions for promoting behaviour change; third, the Theory of Planned Behaviour and its applications in the domain of physical activity. At the end of the literature review, the research objectives are outlined, together with research questions and research hypotheses. Chapter Three describes the methodology used to fulfil the research objectives and answer the research questions. Chapter Four presents the results, and Chapter Five presents a discussion of the findings of the study in the context of current research and practice. Additionally, it presents study limitations, lessons learned, and provides suggestions for future research.

CHAPTER TWO BACKGROUND & LITERATURE REVIEW

CHAPTER OUTLINE

2.1 Physical activity definitions and related concepts

Physical activity is defined as "any bodily movement produced by skeletal muscles that results in energy expenditure" (Caspersen, Powell, & Christenson, 1985, p. 126). This broad definition allows including any kind of activity in the domain of physical activity, because essentially any movement can produce energy expenditure. This definition is especially useful with respect to the World Health Organisation's strategic principles of action: "using a broad definition of physical activity offers far greater potential to engage a range of sectors […]. This means that it should be seen as a shared task of not only the health, sport or leisure sectors but also others, such as transport and the environment" (Cavill et al., 2006, pp. 15–16).

'Exercise', 'physical fitness', and 'active living' are other terms that are often used interchangeably, albeit improperly (Brownson, Boehmer, & Luke, 2005; Caspersen et al., 1985; Taylor, 1983), as synonyms of physical activity. However, there are conceptual differences among them, as Caspersen, Powell and Christenson (1985) pointed out in their seminal paper, which provided a common ground of definitions, typologies and taxonomies for researchers and epidemiologists. Exercise is a type of physical activity or a sub-category of it as it is defined as a "planned, structured, repetitive, and purposive activity with the objective to improve or maintain physical fitness" (Caspersen et al., 1985, p. 128). Physical fitness is defined as "a set of attributes that people have or achieve that relates to the ability to perform physical activity […] to carry out daily tasks with vigour and alertness, without undue fatigue and with ample energy to enjoy leisure-time pursuits and to meet unforeseen emergencies" (Caspersen et al., 1985, p. 129). Hence, physical fitness is the result of an active way of living and can be increased by engaging in regular physical activity. Lastly, active living is "a way of life that integrates at least half an hour of physical activity each day into daily routines" (Cavill et al., 2006, p. 3).

Furthermore, as the etymology of the "in" prefix suggests, the term "inactivity" describes a quality or condition of being inactive ("Inactivity, n.," 2011). As opposed to physical activity, physical inactivity refers to a state of no marked increase energy expenditure (Hagströmer, 2007). In epidemiological terms, a person can be defined as inactive when they are not active enough to gain health benefits (Hagströmer, 2007; Sjöström, Oja, Hagströmer, Smith, & Bauman, 2006).

A distinguishing element of physical activity is the expenditure of energy, which is the amount of energy consumed during the movement and can be expressed through a continuous variable, ranging from low to high. The unit of measurement of energy expenditure for physical activity is the kilojoule (kJ) or kilocalorie (kcal), the latter being equivalent to 4,185 kJ (Caspersen et al., 1985). Caspersen and colleagues' broad definition of physical activity implies that potentially any kind of movement producing energy expenditure can be considered physical activity. However, they acknowledged that the amount and intensity of physical activity "is largely subject to personal choice and may vary considerably from person to person as well as for a given person over time" (Caspersen et al., 1985, p. 127).

To underline the fact that all activities carried out daily on moderate intensity can be beneficial for the health of individuals (Bouchard & Shephard, 1994; Bouchard, Shephard, & Stephens, 1994), in the early 1990s, a new concept of *health-enhancing physical activity* was developed by Ilkka Vuori and Pekka Oja and their research group at the UKK Institute of Tampere, Finland, one of the leading organisations belonging to the European Health-Enhancing Physical Activity (HEPA) Network (Oja, 2009). Health-enhancing physical activity is defined as "any form of physical activity that benefits health and fitness without undue harm or risk" (Foster, 2000). Hence, health-enhancing physical activity can encompass many daily activities, such as brisk walking, walking the dog, gardening, dancing and swimming, and it does not necessarily include sports (Foster, 2000). In the concept of health-enhancing physical activity it is highlighted the fact that physical activity should be moderate or vigorous in order to gain health benefits.

According to Cavill et al., a *moderate-intensity physical activity* "raises the heart-beat and leaves the person feeling warm and slightly out of breath; it increases the body's metabolism to 3-6 times the resting level" (Cavill et al., 2006, p. 3). On the other hand, *vigorous-intensity physical activities* "enable people to work up a sweat and become out of breath. They usually involve sports or exercise, like running or fast cycling; they raise the metabolism to at least six times its resting level (6 METs)" (Cavill et al., 2006, p. 3).

For the purpose of this dissertation the definition of physical activity is: "getting at least 30 minutes of moderate physical activity on at least five days or 20 minutes of vigorous physical activity on at least three days this coming week", which is based on the ACSM/AHA recommendations (Haskell et al., 2007). A detailed discussion about this definition and recommendations is offered in paragraph 2.2.2.

2.1.1 Types of physical activity

Physical activity is a complex behaviour and in principle there are many ways to categorise it. According to the Physical Activity Guidelines Advisory Committee (PAGAC), physical activity can be categorised according to mode or type, intensity, and purpose or domain (PAGAC, 2008).

Mode

Mode is the type of activity that is being performed. Examples of different types of activity are biking, walking, rowing, and weight lifting (PAGAC, 2008, p. C–4), which contribute to moderate or vigorous types of physical activity.

Intensity

Intensity indicates the amount of work performed or the "magnitude of the effort required to perform an activity or exercise" (PAGAC, 2008, p. C–3). Intensity can be expressed in absolute or relative terms. *Absolute intensity* is determined by the rate of work being performed and does not take into account the physiologic capacity of the individual. It refers to the energy expended during a particular activity. For aerobic activity, absolute intensity is typically expressed as the rate of energy expenditure. For example it can be expressed in millilitres per kilograms per minute of oxygen being consumed, kilocalories per minute, or metabolic equivalents (METs) or as the speed of the activity (e.g., walking at three miles per hour, jogging at six miles per hour, etc.), (PAGAC, 2008, p. C–3). Absolute intensity is usually measured in metabolic equivalents (METs). A *metabolic equivalent (MET)* is the "ratio of the work metabolic rate to a standard resting metabolic rate (RMR) of 1.0 kcal $\cdot$ kg $^{-1}$ $\cdot$ h $^{-1}$. One MET is considered the resting metabolic rate of a person at rest" (Ainsworth et al., 2011, p. 1576). Conventionally, a MET is "often characterised as the metabolic cost of resting quietly" (Ainsworth et al., 2011, p. 1577) and is defined as the consumption of 3.5 millilitres of oxygen per kilogram per minute (3.5 $mL^{-1} \cdot kg^{-1} \cdot min^{-1}$).

According to absolute intensity, physical activities can be classified as light, moderate or vigorous, relatively to their assigned energy expenditure values and according to their metabolic equivalents (Bauman, Phongsavan, Schoeppe, & Owen, 2006, p. 93). To classify physical activities according to their metabolic equivalents, Barbara Ainworth and colleagues, since 1993, developed and updated the so called *Compendium of physical activities* (Ainsworth et al., 1993, 2000, 2011). Each activity is assigned a weighted value, following standard indicators and classifications, derived from laboratory or field experiments that measured oxygen cost of specific activities. The first compendium was published in 1993 and reported 476 activities and their associated MET equivalents. The MET values in the compendium range from 0.9 for sleeping to 23 METs for running at 14.0 mph. In the 2011 update of the *Compendium*, Ainsworth and colleagues included 821 codes for physical activities based on their metabolic equivalents.

The concept of *relative intensity* of physical activity is related to an individual's exercise capacity, so it is relative to the individual characteristics. For example, in aerobic exercise, relative intensity is expressed as a percentage of a person's aerobic capacity (VO^2max) or VO^2 reserve, or as a percentage of a person's measured or estimated maximum heart rate (PAGAC, 2008, p. C–3). A self-reported evaluation of exertion or fatigue can be used as indication of relative intensity. A commonly used instrument to rate perceived exertion is the Borg Scale (Borg, 1998), which is used for both aerobic and muscle-strengthening types of activities.

In addition to the notion of intensity, physical activity can also be characterised through the dimensions of *frequency* and *duration* (Macera, Hootman, & Sniezek, 2003,

p. 122). Frequency is the amount of times an activity is performed in a given time frame, which is usually a recently recalled period such as the past week, or a ‘usual week’ (i.e., usual weekday or weekend), or in the past two weeks (Bauman et al., 2006). Duration indicates the total amount of time an activity is performed either continuously during one session or accumulated over a specified time in a given session or occasion, expressed as time per day or per time frame chosen. Duration can be expressed as an average of or total of hours and minutes (Bauman et al., 2006, p. 93).

Purpose or domain

Physical activity can be classified also by purpose or domain. As noted by Caspersen and colleagues (1985), a simple way to categorise physical activity is by considering the portions of daily life in which certain activities are carried out with a specific purpose (e.g., physical activity for commuting to work or for transportation, etc.). Another common categorisation of physical activity is in domains, which in other terms correspond to locations or settings where physical activities are carried out or performed. Essentially, there are four domains that are frequently reported in the literature and are measured in global aid international epidemiologic studies. These include: a) *leisure-time* (LTPA), b) *occupational* or work domain, c) *domestic* or house domain, and d) *active transportation* or *active commuting*. Leisure time domain can include organised activities, such as sports, walking for recreation and gym classes, and also non-organised sports, walking for exercise etc. (Bauman et al., 2006; Orsini, 2008). The occupational or work domain includes the energy expended during work or for other occupations. The domestic domain includes all activities carried out at home, such as in-house chores, physically-active child care, general household activities, and also outside, such as gardening and yard work. Active transportation encompasses those activities that are conducted for commuting from a place to another, including walking or cycling with the purpose of going somewhere.

According to Bauman and colleagues (2006), there are other two domains that should be considered when defining physical activity and describing a population. The first is *incidental energy expenditure*, which may occur when, for example, one uses stairs instead of the elevators in buildings. The second is sedentariness, which is described by sedentary behaviours, for example watching television, using a computer, reading, or sitting at work (Bauman et al., 2006, p. 94).

2.1.2 Measuring physical activity

The definitions and classifications of physical activity presented above are an expression of the many ways in which physical activity can be measured and operationalized. Caspersen and colleagues suggested that each categorisation of physical activity should be done in such a way that categories are "mutually exclusive and that they sum to the total caloric expenditure" (Caspersen et al., 1985, p. 127). Duration, frequency, and intensity are example indicators of how physical activity can be measured and domains allow physical activity to be classified.

Physical activity measurement is useful not only for providing more accurate definitions and classifications of activities, but also for monitoring the health status of different populations. In fact, Bauman, Phongsavan, Schoeppe and Owen (2006) suggest that measuring physical activity is important for public health and health promotion because it allows to: a) understand its relationship with various physical and mental health related outcomes (e.g., reduced risk of coronary heart disease, diabetes, reduced depression); b) monitor physical activity levels among different populations; c) understand correlates and determinants in order to explain why some people or groups engage in physical activity more than others; d) measure the impact of health promotion programmes and interventions; e) provide a "sound and strong eveidence base for broader initiatives in health promotion policy and practice" (Bauman, Phongsavan, Schoeppe, & Owen, 2006, p. 92).

There are multiple ways to assess physical activity, and each of them have strenghts and weaknesses. One of the possible ways to assess physical activity involve the use of "objective" measures of physical activity, which include physiological measures of fitness (oxygen uptake through exercise or fitness tests), energy expenditure using direct calorimetry, or measures obtained with the use of technologies, such as heart rate monitors or motion sensors (e.g., pedometers or accelerometers) (Bauman et al., 2006). Among the biggest limitations of these studies there are the costs of the appliances, which result in reduced sample sizes and reduced generlizability of the study, and the fact that the instrument itself serves as intervention, hence influencing the behaviour. An alternative method to collect information about physical activity is through direct observation. Examples of these measures include the SOFIT (System for Obserbving Fitness Instruction Time) or the SOPLAY (System for Observing Play and Leisure Activity in Youth) systems (McKenzie, Marshall, Sallis, & Conway, 2000; McKenzie, Crespo, Baquero, & Elder, 2010; McKenzie, Sallis, & Nader, 1991). Also this method has limitations. For instance, the researcher might introduce bias while recording somebody else's activities, or the respondents might act differently, simply by the fact that they are observed.

In real life settings, many studies that deal with physical activity measurement frequently rely on self-reported measures (e.g., self-administered questionnaires, interviews or surveys), because of the ease of use and the reduced costs involved in collecting that information. Alternatives to self-reported measures of physical activity include self-reported activity logs or diaries, where respondents periodically record information about their physical activities during a week or a day (Bauman et al., 2006). The limitations of self-reported measures include social desirabily bias, which becomes apparent through under- or over-reporting of the time spent in physical activities, when respondents desire to appear more active than they are (Bauman et al., 2006). Examples of validated and highly utilised self-reported questionnaires include the International Physical Activity Questionnaire (IPAQ Research Committee, 2005, 2011) and the Global Physical Activity Questionnaire (Armstrong & Bull, 2006). The IPAQ has two versions, a short form and a long form. The IPAQ short form (IPAQ-S) assesses duration and intensity of physical activity in three dimensions: moderate, vigorous and walking, whereas the IPAQ long form (IPAQ-L) measures physical activity in five domains (work, domestic and garden, active transportation, leisure-time physical activity, and time spent sitting). The short version is suitable for use in national and regional surveillance systems, while the long version provides more detailed information often required in research work or for evaluation purposes (IPAQ Research Committee, 2011). The IPAQ-L in particular is considered appropriate when dealing with research purposes and when specific and more detailed assessment of physical activities is required (Craig et al., 2003) and has been recently evaluated for its applicability in occupational physical activity domain (Kwak, Hagströmer, & Sjöström, 2011). Both IPAQ-S and IPAQ-L surveys assess physical activity recalled during the last seven days. Since 1998, when the instrument was developed, many studies tested its validity against fitness (Fogelholm et al., 2006) or against objective measures such as accelerometers (e.g., Boon, Hamlin, Steel, & Ross, 2010; Ekelund et al., 2006a; Fillipas, Cicuttini, Holland, & Cherry, 2010). Furthermore, its validity and reliability were tested in studies involving various countries (Craig et al., 2003; Dumith, Hallal, Reis, & Kohl, 2011; Hallal et al., 2010), and across diverse settings and adult populations (Ekelund et al., 2006a; Hagströmer et al., 2008; Hagströmer, Oja, & Sjöström, 2006; Hallal et al., 2010). Regarding its reliability, Craig and colleagues (2003) reported that IPAQ questionnaires yielded a Spearman's rho of about .80, suggesting a positive association of physical activity measures, with relative large effects for both short and long forms. Regarding criterion validity, Craig et al. reported a median Spearman's rho of about .30, which was considered comparable to other self-report validation studies. Moreover, the authors found that telephone administered and self-administered surveys were similarly reliable (Craig et al., 2003). Similar results in terms of criterion validity were found in other studies. For example, Ekelund et al. (2006), who evaluated the instrument in a population of Swedish adults, found that the IPAQ showed moderate criterion validity (r ranging from .16 to .35), and it was significantly correlated ($r = .34$, $p < .001$) with the accelerometer (Ekelund et al., 2006). In Fillipas and colleagues' study (2010), the correlation coefficient ($r = .41$) was comparable to the previous studies. Overall, findings suggest that this instrument can be considered acceptable and valid for measuring physical activity in various settings and countries across the world (Bauman, Bull, et al., 2009; Bauman, Ainsworth, et al., 2009).

Similar to the IPAQ, the Global Physical Activity Questionnaire (GPAQ) measures duration and intensity of physical activity in three domains: work (paid and unpaid), transport (i.e., walking and cycling to get to and from places), and discretionary time (leisure, recreation, etc.). It was developed by the Department of Chronic Diseases and Health Promotion Surveillance and Population-Based Prevention of the World Health Organisation to provide a valid instrument for physical activity surveillance in countries especially in developing countries (Armstrong & Bull, 2006). Reliability and validity tests were undertaken by the same developers of the instrument in various countries (i.e., Bangladesh, Brazil, China, Ethiopia, India, Indonesia, Japan, Portugal, and South Africa) and were reported in two papers (Armstrong & Bull, 2006; Bull, Maslin, & Armstrong, 2009). In the first one, Armstrong and Bull reported good results for concurrent validity, with a moderate-to-good correlation coefficient ($r = .54$), “fair” results for criterion validity was fair ($r = .31$), and good-to-excellent results for test-retest reliability (r ranging from .67 to .81), which indicated a high level of repeatability between administrations (Armstrong & Bull, 2006, p. 68). In the second paper (Bull, Maslin & Armstrong, 2009), reliability coefficients were moderate to strong (Kappa ranged from .67 to .73; Spearman’s rho from .67 to .81). Concurrent validity estimates confronting IPAQ and GPAQ showed a moderate to strong positive relationship (range: from .45 to .65). However, estimates for criterion validity were in a poor-fair range (from .06 to .35). Even though GPAQ provided reproducible data and showed a moderate-strong positive correlation with IPAQ, it presented issues with regards to validity (Bull et al., 2009).

2.2 The importance of physical activity for health

Physical activity is an important determinant of health and it is generally acknowledged that regular physical activity decreases the risk of developing long-term chronic conditions, and that it improves perceived and actual health and overall well-being (Bauman, 2004; Blair, Kohl, Gordon, & Paffenbarger, 1992; Warburton, Nicol, & Bredin, 2006). Also, the levels and patterns of physical activity are often used as public health indicators of the health status of a given population (Bauman, Bull, et al., 2009; Bauman et al., 2006; OECD, 2010; Rütten et al., 2003; Sjöström et al., 2003).

Physical activity has been recognised as a key element in the development and maintenance of a healthy life-style since ancient times. In primitive societies physical activity was essential for the survival of the species, and it was even ritualised in forms of dance or similar activities. The Greeks highly emphasised the benefits of activity for a complete and balanced development of body and mind for athletes, soldiers, and people in all classes and social strata (MacAuley, 1994; Paffenbarger, Blair, & Lee, 2001).

In modern times, the changes in the environment and the fast-growing, high-demanding society resulted in a physiological and physical shift towards less activity (Sparling, Owen, Lambert, & Haskell, 2000). The role of physical activity in maintaining good health has been demonstrated by a long tradition in epidemiologic research. Many systematic reviews published in the last 60 years have continuously affirmed many benefits of physical activity in various health domains (Bauman, 2004; Bize, Johnson, & Plotnikoff, 2007; Warburton et al., 2006). Furthermore, various health organisations at a global, international, national and local levels produced statements, common agendas, guidelines and recommendations with the aim to educate the general public and guide public health decision makers through the process of planning and implementing actions to promote physical activity (BHF 2007; CDC, 2001; DH, 2011; Haskell et al., 2007; Oja, Bull, Fogelholm, & Martin, 2010; PAGAC, 2008; USDHHS, 1996, 2008; USPSTF, 2002; WHO, 2010).

It is widely acknowledged that regular physical activity is associated with reduced risk of developing heart disease, chronic respiratory diseases, diabetes and metabolic syndrome, obesity-related conditions, and various cancers (CDC, 2001, 2010; OECD, 2010; WHO, 2009, 2011). Physical activity is also important for managing and maintaining optimal weight, strengthening bones and muscles, improving mental health and mood (Cavill et al., 2006; CDC, 2010; European Commission, 2011). Some recent reviews show that the lack of physical activity (or physical inactivity) is one of the key risk factors of rheumatic diseases (Turesson & Matteson, 2007). Moreover, the United Nations have recognised sport, a specific type of physical activity, as a strategic element for preventing and managing both noncommunicable diseases and infectious diseases, and enhancing mental health (UN, 2011). Sport is also considered a viable tool to assist in the achievement of the eight Millennium Development Goals (UN, 2010).

In the following paragraphs an historical overview of relevant epidemiologic research findings and public health milestones is presented, with a focus on the major health benefits associated with regular physical activity.

2.2.1 Health benefits of physical activity: an historical perspective

2.2.1.1 Physical activity and noncommunicable diseases

The first systematic epidemiologic investigations on the role of physical activity in reducing cardiovascular diseases were conducted among the working class, immediately after the Second World War, with the pioneering seminal work of Jeremy N. Morris and his associates (Orsini, 2008; Paffenbarger et al., 2001). Morris and colleagues studied the population of London busmen and identified physical activity as one of the key determinants of coronary heart disease (Heady, Morris, Kagan, & Raffle, 1961; Heady, Morris, & Raffle, 1956; Morris, 1959; Morris & Crawford, 1958). The results of these early investigations showed that individuals in active occupations had lower rates of heart disease than individuals in sedentary occupations.

In the following decades, scholars like Ralph Paffenbarger, Steven Blair, Kenneth Powell, Adrian Bauman, Rod Dishman, James Sallis, and Carl Caspersen, continued to examine the relationship between physical inactivity and cardiovascular diseases in different populations and settings expanding to other health and disease-specific domains (Blair & Morris, 2009; Erlichman, Kerbey, & James, 2002a; Paffenbarger et al., 2001), including hypertension, diabetes mellitus, and osteoporosis (Siscovick, Laporte, & Newman, 1985), and mental health (Taylor, Sallis, & Needle, 1985). Some studies examined the association of physical inactivity with other health-related behaviours, such as smoking, substance abuse, stress management and overeating (Blair, Jacobs, & Powell, 1985).

In 1986, Paffenbarger and colleagues showed that exercise was inversely related with decreasing death rates in physical activity among Harvard College alumni (Paffenbarger, Hyde, Wing, & Hsieh, 1986). Alumni mortality rates were “significantly lower among the physically active and […] by the age of 80, the amount of additional life attributable to adequate exercise, as compared with sedentariness, was one to more than two years” (Paffenbarger et al., 1986, p. 605). Similar results were found in older populations, where even a small increase in moderate physical activities produced tangible improvements in many physical and psychological parameters and in the decrease of health diseases (Gorman & Posner, 1988). In the following years, Paffenbarger and associates continued to find evidence that active people tended to live longer and had fewer chances to die from heart failure or sudden death (Lee, Paffenbarger, & Hennekens, 1997; Paffenbarger & Lee, 1996; Powell & Paffenbarger, 1985).

At the end of the 1980s, the growing and compelling evidence of the health benefits of exercise and physical activity brought the scientific community to produce the first *consensus statement* as result of two international conferences held in Toronto, Canada, in 1988 (Bouchard, Shephard, Stephens, Sutton, & McPherson, 1990) and in 1992 (Bouchard et al., 1994). In the same period, the American Heart Association (AHA) published an official *Statement on exercise: benefits and recommendations for physical activity programs for all Americans.* In this document, experts of the Committee on Exercise and Cardiac Rehabilitation recognised physical inactivity as major independent risk factor for coronary heart diseases and overall mortality (Fletcher et al., 1992).

The U.S. Surgeon General’s 1996 report acknowledged that physical activity was responsible not only for reduced risks of overall mortality, sudden death, cardiovascular diseases and colon cancer, but also for other health conditions, such as type 2 diabetes, osteoporosis, arthritis, musculoskeletal injury, and obesity, and for an overall improvement in psychological well-being, mental health and health-related quality of life (USDHHS, 1996).

In their seminal systematic review about the relationship between exercise or physical activity and other health behaviours, Blair and colleagues (1985) discovered that physical activity could act as both independent and mediating variables. They found that active individuals were more likely to engage in other preventive health behaviours, because "they are generally related to an orientation of health protection, promotion, or prevention" (Blair et al., 1985, p. 177). Data suggested that regular physical activity was positively associated with better weight control and high caloric intake, on one hand because active people tended to eat more and more frequently due to high energy consumption associated with exercise; on the other hand, because overweight people were more likely to be "characterised as under exercised rather than overfed" (Blair et al., 1985, p. 175).

At the end of 1990s, Lee, Paffenbarger and Hennekens urged public health professionals worldwide to "emphasise the need to increase activity levels during leisure time, as well as the need to incorporate physical activity into the daily activities of life" (Lee et al., 1997). In the 2000s, other systematic reviews continued to identify positive public health benefits of physical activity (Macera et al., 2003) and reaffirmed the effectiveness of regular physical activity on various health outcomes, in particular overweight and obesity, and cardiovascular health (Bauman, 2004; Erlichman et al., 2002a; Erlichman, Kerbey, & James, 2002b; Neve, Morgan, Jones, & Collins, 2010; Shaw, Gennat, O'Rourke, & Del Mar, 2006; Withrow & Alter, 2010).

Similar attention to the role of physical activity research was given by the European Commission, which established in 1996 the European Network for the promotion of Health Enhancing Physical Activity (the HEPA Network). HEPA is "an open, multi-disciplinary network of scientists, policy makers and practitioners aiming at the realisation of the potential of physical activity for public health" (Oja, 2009, p. 423). The HEPA Network aims to "promote the health and well-being of European citizens by facilitating the development of national health-enhancing physical activity policy"

(Foster, 2000, p. 5). In response to the U.S. Surgeon General's report, Ilkka Vuori emphasised the health benefits of regular physical activity on physiological responses, overall mortality, overall functional capacity, mental health and overall quality of life. Vuori stressed that these benefits could be gained by engaging in moderate daily physical activity, which does not necessarily require a high level of skills or specialized equipment or facilities (Vuori, 1998).

In the 2000s, it became clear that "physical activity reduces cardiovascular risk through lowering of blood pressure, improved glucose tolerance, reduced obesity, improvement in lipid profile, enhanced fibrinolysis, improved endothelial function and enhanced parasympathetic autonomic tone" (Adamu, Sani, & Abdu, 2006, p. 190). In the past decade, the evidence continues to illustrate that regular physical activity is associated with reduced risk of developing heart diseases (Blair & Morris, 2009; Buchner, 2009; Gill, 2007; Hamilton, Hamilton, & Zderic, 2007; McGavock, Sellers, & Dean, 2007; Murtagh, Murphy, & Boone-Heinonen, 2010). In the European context, several studies conducted within the HEPA Network provided additional support to the scientific community and to public health organisations about the health benefits of regular health-enhancing physical activity (Foster & Hillsdon, 2004; Martin, Kahlmeier, et al., 2006; Martin, Mäder, Studer, & de Keyzer, 2006; Oja et al., 2010; Vuori, 2001; Vuori, Lankenau, & Pratt, 2004).

The important role played by physical activity was further recognised when the World Health Assembly and the World Health Organisation included physical inactivity as one of the leading risk factors for noncommunicable diseases (WHO, 2000a, 2000b). Noncommunicable diseases (NCDs) include cardiovascular diseases (CVD), chronic respiratory diseases, diabetes, various cancers and obesity-related conditions (WHO, 2009, 2011). The Report of the Director-General, prepared for the 53rd World Health Assembly in 2000, set the basis of a *Global strategy for the prevention of noncommunicable diseases* (WHO, 2000a). Subsequently, the Resolution WHA53.17 (WHO, 2000b) urged governments and institutions to work together on a global scale and at international, national and local levels to tackle the growing global health issue of noncommunicable diseases.

Additionally, two years later, to “draw the attention of policy-makers, the public health community and civil society to the major epidemic of noncommunicable diseases” (WHO, 2002, para. 2), the WHO dedicated the World Health Day 2002 to fitness and a healthy lifestyle. In 2004, the 57th World Health Assembly, through the resolution WHA57.17, formally endorsed the *Global Strategy on Diet, Physical Activity and Health* (WHO, 2004). In the same period, the U.S. Department of Agriculture dedicated physical activity a specific chapter in the updated dietary guidelines for Americans (USDA, 2000) and the Department of Health and Human Services, reaffirmed the benefits of physical activity for general overall health and well-being (USDHHS, 2002).

In 2004, the American Cancer Society, the American Diabetes Association, and the American Heart Association set a common agenda for more coordinated efforts in the prevention of cancer, cardiovascular disease and diabetes (Eyre, Kahn, & Robertson, 2004). Furthermore, the 2007 World Cancer Research Fund (WCRF) and the American Institute for Cancer Research’s (AICR) systematic review provided a global perspective on *Food, nutrition, physical activity and the prevention of cancer* (WCRF & AICR, 2007). They reported that the evidence of the protective role of physical activity against colon cancer was convincing, and that there was probable evidence about the reduction of prevalence of postmenopausal breast cancer, endometrium cancer, and limited evidence about premenopausal breast cancer, lung and pancreatic cancer (WCRF & AICR, 2007, pp. 199, 208–209).

In 2008, the U.S. Department of Health and Human Services published a comprehensive review of the evidence of physical activity and health: the 2008 *Physical Activity Guidelines Advisory Committee Report* (PAGAC, 2008). In this report, the panel of experts confirmed the role of physical activity in a wide range of positive health benefits, including cardiorespiratory health, metabolic health, mental health, musculoskeletal health, functional health, cancer prevention.

In recent years, many systematic reviews reinforced the evidence on the important role of physical activity in prevention and management of metabolic syndrome and type 2 diabetes in various adult populations (Barrett, Plotnikoff, Courneya, & Raine, 2007;

Gill, 2007; Gill & Cooper, 2008; Hamilton et al., 2007; Hayes & Kriska, 2008; Lakka & Laaksonen, 2007; McGavock et al., 2007; Pedersen & Saltin, 2006; Plotnikoff, Lippke, Courneya, Birkett, & Sigal, 2010; Weinstein & Sesso, 2006).

Regarding cancer prevention, it is hypothesised that physical activity is associated with a reduced onset of cancer by its impact on hormone levels, percentage of body fat, and on the enhancement of the immune system (Kruk & Aboul-Enein, 2006). Newton & Galvão (2008) suggest that planned exercise is important for cancer survivors as it "improves symptom experience, ameliorates treatment side effects, enhances psychological well-being, and appears to increase survival through a range of mechanisms" (Newton & Galvão, 2008, p. 144).

2.2.1.2 Psychological well-being, mental health and health related quality of life

Early reviews and studies about the association between physical activity and improved mental health are from the 1980s (Powell & Paffenbarger, 1985; Taylor et al., 1985). Current research has found convincing and consistent evidence suggesting that physical activity has positive effects on mental health. In particular, the most beneficial effects of physical activity for mental health are to be found in leisure-time physical activity, since it encompasses physical, mental and social components that could reduce the likelihood of developing dementia in an older age (Fratiglioni & Wang, 2007). Physical activity is also considered a good antidepressant and it is used in the treatment of depression and anxiety disorders (Ströhle, 2009). Blumenthal and colleagues (2007) studied the association of physical activity and major depressive disorder (MDD), and discovered that patients that were allocated in an exercise intervention group, had generally similar positive outcomes compared to patients receiving antidepressant medication (Blumenthal et al., 2007). In a follow-up study authors discovered positive effects of exercise, which "seems to extend the short-term benefits and augment the benefits of antidepressant use" (Hoffman et al., 2011, p. 127).

Physical activity is also considered an useful antidote to stress in the general population (Blair et al., 1985; Paluska & Schwenk, 2000; Taylor et al., 1985) and was found to be an important outcome in interventions preventing back pain among working age adults (Bigos et al., 2009).

2.2.2 The development of physical activity recommendations for adults

Since the early 1990s, public health recommendations, guidelines and statements were published with the aim to set the minimum thresholds for physical activity for various populations and age groups. In the following paragraphs the major milestones in the definition of physical activity recommendations for adults are presented and are summarised in Table 2.1.

The first set of public health recommendations for physical activity (Pate et al., 1995) was published by the U.S. Centres for Disease Control and Prevention (CDC) and the American College of Sports Medicine (ACSM), a few years after the first *Statement on exercise: benefits and recommendations* (Fletcher et al., 1992). The CDC/ACSM recommended that every adult should accumulate “30 minutes or more of moderate-intensity physical activity on most, preferably all, days of the week” (Pate et al., 1995, p. 402). These recommendations were considered an important public health benchmark for many countries and set a milestone in the establishment of public health awareness about the consequences of physical inactivity.

In 1996, the U.S. Department of Health and Human Services (HHS) published the *Report of the Surgeon General*, a pivotal document summarising the latest evidence about physical activity and health. The recommendation of engaging in regular moderate physical activity was addressed to all segments of the population and referred to: “a moderate amount of physical activity is roughly equivalent to physical activity that uses approximately 150 Calories (kcal) of energy per day, or 1,000 Calories per week” (USDHHS, 1996, p. 2). These recommendations were addressed to various segments of the population, such as older adults, parents, teenagers, dieters, and people with high blood pressure, people feeling anxious, depressed or moody, or people with arthritis and with disabilities. The Report provided also a list of examples of moderate activities that could help achieve health benefits, from less vigorous ones (e.g., washing and waxing a car for 45-60 minutes) to more vigorous and for less time (e.g., walking up and down the stairs for 15 minutes). The Report of the Surgeon General brought in a "new view of physical activity", and introduced the concept that even small improvements in regular physical activity could significantly increase health outcomes among insufficiently active or inactive people (USDHHS, 1996).

In the same year, the American Heart Association published an updated *Statement for Health Professionals* by the Committee on Exercise and Cardiac Rehabilitation of the Council on Clinical Cardiology (Fletcher et al., 1996). The *Statement for Health Professionals* included the 1996 CDC/ACSM recommendations and urged professionals to develop interventions to promote physical activity as well as to put the recommendations into practice.

The '30 minutes per day formula' was present also in the 2000 Guidelines of the HEPA Network: for instance, it was stressed that physical activity can be effective even if it is not strenuous: "Thirty minutes a day of moderate-intensity activity is enough to benefit health" (Foster, 2000, p. 9). In the same period, the Institute of Medicine (IOM) raised some criticisms towards the CDC/ACSM recommendations, suggesting that 30 minutes per day of regular activity were not sufficient to maintain a healthy body weight. So, to prevent weight gain they recommended to engage in at least 60 minutes of daily moderate intensity physical activity, for example walking or jogging at 4 to 5 mph (IOM, 2002).

However, as Blair, LaMonte and Nichaman noted, these recommendations refer to different outcomes. IOM recommendations were associated with the outcome of reduced weight gain as opposed to those published by the ACSM/AHA, which referred to a broader range of general health benefits. To bring clarification and provide a more consensual recommendation, Blair and colleagues tried to harmonise public health and a medical physical activity recommendations by incorporating the "30 min of moderate-intensity activity per day" formula and additional indications for weight loss (Blair, LaMonte, & Nichaman, 2004). In the following years, these guidelines were used in many European countries, through the efforts of the HEPA Network. For example, in 2006, the Swiss Federal Offices of Sports and Public Health, Health promotion

Switzerland and the Swiss HEPA Network HEPA produced a base document containing health-enhancing physical activity recommendations (2006).

Muscle strengthening activities and weight control were also included in the WHO *Global Strategy for Physical Activity and Diet*. In addition to stressing the fact that engaging in a least 30 minutes of regular, moderate- intensity physical activity on most days reduces the risk of cardiovascular disease and diabetes, colon cancer and breast cancer, it was suggested that "muscle strengthening and balance training can reduce falls and increase functional status among older adults and more activity may be required for weight control" (WHO, 2004, p. 4).

In 2007, the American College of Sports Medicine and the American Heart Association published an updated physical activity recommendation statement for adults from 18 to 65 years of age. These recommendations included indications about moderate intensity and vigorous intensity activities as follows (Haskell et al., 2007, p. 1083):

> All healthy adults aged 18-65 years need moderate-intensity aerobic physical activity for a minimum of 30 min on five days each week or vigorous-intensity aerobic activity for a minimum of 20 min on three days each week. Also, combinations of moderate- and vigorous intensity activity can be performed to meet this recommendation.

Also, in order to promote and maintain good health and physical independence, it was recommended that adults performed strengthening and endurance activities as part of a weekly routine (Haskell et al., 2007). Similar recommendations were included in the Second Expert Report of the World Cancer Research Foundation (WCRF) and American Institute of Cancer Research (AICR). For cancer prevention, the WCRF/AICR recommended that people engage in moderate activities, equivalent to brisk walking, for at least 30 minutes every day. Furthermore, as fitness improves people should "aim for 60 minutes or more of moderate, or for 30 minutes or more of vigorous, physical activity every day" (WCRF/AICR, 2007, pp. 376–378).

The 2007 ACSM/AHA recommendations were considered a reference point in the field of health promotion in many other health domains and were used as guidance documents for public health initiatives worldwide (Haskell et al., 2007). In 2010 the WHO published a first set of *Global recommendations on physical activity for health*

(WHO, 2010). These recommendations include slightly different wording and reference indicators for time spent in physical activities, but maintain the distinction between moderate and vigorous activities. They also include suggestions to incorporate muscle strengthening activities in weekly training.

Table 2.1. Milestones in the development of physical activity recommendations for adults

Organisation	Year	Recommendation
CDC, ACSM; USDHHS	1995, 1996	30 minutes or more of moderate-intensity physical activity on most, preferably all, days of the week.
HEPA	2000, 2006	30 minutes a day of moderate-intensity activity is enough to benefit health.
IOM	2002	at least 60 minutes of daily moderate intensity physical activity, for example walking or jogging at 4 to 5 mph.
ACSM, AHA; WCRF/AICR	2007	A minimum of 30 min on five days each week or vigorous-intensity aerobic activity for a minimum of 20 min on three days each week. Additionally, include 8-10 muscle strengthening exercises on two or more non-consecutive days each week.
WHO	2010	At least 150 minutes of moderate-intensity aerobic physical activity throughout the week, or do at least 75 minutes of vigorous-intensity aerobic physical activity throughout the week.
DH	2011	Adults should aim to be active daily. Over a week, activity should add up to at least 150 minutes (2½ hours) of moderate intensity activity in bouts of 10 minutes or more – one way to approach this is to do 30 minutes on at least 5 days a week. Alternatively, comparable benefits can be achieved through 75 minutes of vigorous intensity activity spread across the week or a combination of moderate and vigorous intensity activity.

*Notes:*ACSM: American College of Sports Medicine (Pate et al., 1995; Haskell et al., 2007); AHA: American Heart Association (Haskell et al., 2007); CDC: Centres for Disease Control and Prevention (USDHHS, 1996); DH: Department of Health of the United Kingdom (DH, 2011a); IOM: Institute of Medicine (IOM, 2002); WCRF/AICR: World Cancer Research Fund, American Institute for Cancer Research (WCRF/AICR, 2007); WHO: World Health Organisation (WHO, 2010).

In the United Kingdom, these updated guidelines were used as a reference point for the development of the first state-wide set of guidelines (DH, 2011). The *UK physical activity guidelines* were published in 2011 and build on the evidence of the report on physical activity by the Chief Medical Officers *Start active, stay active* (DH, 2011b) and include recommendations for the following segments: people under 5 years (capable and incapable of walking), children and young people from 5 to 18 years of age, adults (19-64 years), and older adults (65+ years). Similarly to the WHO Global guidelines, the UK recommendations for adults refer to 150 minutes of moderate intensity activity in a week or 75 minutes of vigorous activities or a combination of both moderate and vigorous. The updated recommendations suggest that it is sufficient to add up bouts of 10 minutes or more, and stress the importance of daily physical activity, muscle strengthening activities (for at least two days a week) and minimise the time spent sedentary (sitting).

2.3 Physical inactivity as a global public health issue

Despite the known and well documented benefits of physical activity, physical inactivity is one of the biggest preventable health problems of the 21st century (Blair, 2009). Since the 1996 *Report of the Surgeon General*, physical activity was considered a serious, nationwide problem, whose scope "poses a public health challenge for reducing the national burden of unnecessary illness and premature death" (USDHHS, 1996, p. 1). Physical inactivity impacts on the health of millions of people around the world, living in both developed and developing countries (Cavill, Kahlmeier, & Racioppi, 2006; Sjöström et al., 2003; WHO, 2011). It was estimated that in 2005, physical inactivity accounted for 200,000 to 300,000 deaths per year in the United States (Brownson et al., 2005). According to the World Health Organization (WHO), physical inactivity is the fourth leading behavioural risk factor for mortality, causing an estimated 3.2 million deaths per year globally (WHO, 2011b, para. 2). It is also estimated that physical inactivity accounts for approximately 600,000 deaths per year, and for the loss of 5.3 million years of healthy lives in Europe (Cavill et al., 2006).

Physical inactivity is also considered the fourth leading health risk factor for noncommunicable diseases (NCDs), and in 2011, according to the WHO's 2010 Global status report, 36 out of the 56 total million deaths per year (about 64%) were due to noncommunicable diseases (WHO, 2011c), and almost half (47%) of the global burden of disease.

The problem of noncommunicable diseases is not new. Ten years ago, the 2002 WHO World Health Report showed that noncommunicable diseases accounted for approximately 60% of all deaths and 43% of the global burden of disease, and were expected to rise to 73% and 60% respectively by 2020 (WHO, 2002). It was also estimated that, in 2005, 80% of NCD deaths occurred in developing countries (WHO, 2005). In a more recent study, Lopez and colleagues (2006), analysed epidemiological data, published between 1990 and 2001, which showed that NCDs accounted for more than half of deaths in adults aged 15-59 in all regions, except South Asia and Sub-Saharan Africa, where HIV/AIDS, infectious and parasitic diseases, maternal and nutritional conditions, remained responsible for over two-thirds of the deaths (Lopez, Mathers, Ezzati, Jamison, & Murray, 2006).

Regarding the association between physical inactivity and noncommunicable diseases, it is estimated that it accounts for around 21-25% of breast and colon cancer burden, 27% of diabetes and about 30% of ischaemic heart disease burden (WHO, 2009, p. 18). The 2002 WHO World Health Report suggested that physical inactivity was responsible for about 3% of the global burden of disease in developed countries and more than 20% of cardiovascular diseases and 10% of strokes (WHO, 2002).

2.3.1 Current global patterns of physical inactivity

In 2008, the WHO estimated that globally around 31% of adults aged 15 and over were insufficiently active, with men being more active than women (WHO, 2011c). Overall, the highest prevalence of physical inactivity was registered in the WHO Regions of Americas and Eastern Mediterranean. In the former, almost 50% of women and 40% of men were insufficiently active, whereas in the latter the prevalence was 36% for both genders (WHO, 2011d). Figure 2.1 shows a world map representing the prevalence of physical inactivity across the six WHO Regions (Africa, Americas, Eastern Mediterranean, Europe, South-East Asia, and Western Pacific). The following data were elaborated by the Global Health Observatory (WHO) in 2008 and are extracted from the WHO Global Observatory website (WHO, 2011a, 2011b). The darker red colour illustrates the countries with prevalence of insufficient physical activity higher than 60%.

In each of the WHO Regions, the countries with the highest prevalence of physical inactivity were the following: in the African region, Swaziland (69%); in the Americas, Argentina (68.8%) and Dominican Republic (60%); in Easter Mediterranean, Saudi Arabia (68.8%), Kuwait (64.5%), and United Arab Emirates (62.5%); in Europe, Malta (71.9%), Serbia (68.3%), and the United Kingdom (63.3%); in Western Pacific, the Cook Islands (72%, the highest prevalence in the world), Federated states of Micronesia (66.3%), Malaysia (61.4%), and Japan (60.2%).

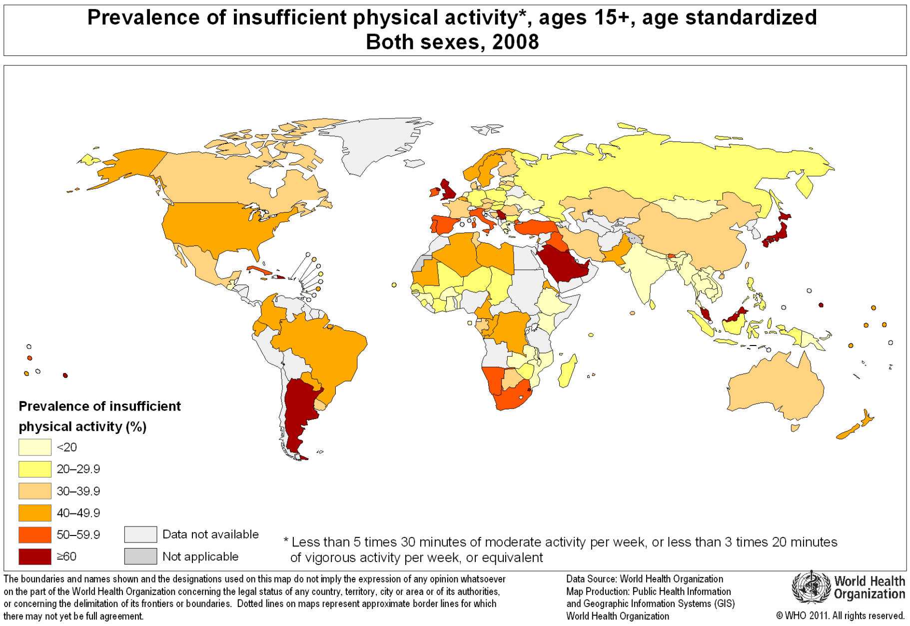

Figure 2.1. Prevalence of insufficient physical activity for adults (age 15+) in 2008

While high rates of physical inactivity were distributed across the planet, the countries with the lowest rates of physical inactivity (i.e., less than 20% of the entire population) were mainly concentrated in the South East Asian Region, with overall 15% of men and 19% of women being insufficiently active (WHO, 2011a). In this region, the lowest overall percentages of inactive population were to be found in Bangladesh (4.7%) – which has also the lowest prevalence in the world – followed by Myanmar (12.7%), Nepal (15.5%), India (15.6%), and Thailand (19.2%).

In Africa, there are 12 countries in which the prevalence of physical inactivity is less than 20%; Mozambique (7.1%), Comoros (8.3%), Benin (9.1%), Malawi (10.2%), Guinea (12.1%), Burkina Faso (15.5%), Kenya (16.5%), Zambia (17.2%), Ghana (17.6%), Sao Tome and Principe (19%), Ethiopia (19.3%), and Sierra Leone (19.9%). Similar results were also found in a meta-analysis measuring the prevalence of diabetes and physical inactivity in West African countries, where the overall prevalence of physical inactivity was 13% (Abubakari et al., 2009).

In the Americas, Guatemala has the lowest prevalence in the entire region (16.2%). In Europe the 'most active' countries are Greece (15.6%), Estonia (17.2%), Netherlands (18.2%), and Ukraine (18.4%). In Western Pacific, Mongolia (9.4%), Cambodia (11.2%), Viet Nam (15.3%), Laos People's Democratic Republic (18.8%), and Papua New Guinea (19.3%). Overall, more than half of the European population does not meet the recommended levels of physical activity and this trend is negative, pointing towards less activity (WHO, 2011b).

These findings are supported by recent reviews and studies that compared and collected data in several countries. Dumith and colleagues (2011), created the most comprehensive estimate of worldwide physical inactivity prevalence to date (Bèlanger & Foster, 2011) by conducting a pooled analysis of secondary data collected by three multi-centre studies (Bauman, Bull, et al., 2009, 2009; Guthold, Ono, Strong, Chatterji, & Morabia, 2008; Sjöström et al., 2006). The earliest study summarised the results of Wave 58.2 of the Eurobarometer survey in 15 European countries (Sjöström et al., 2006). Another study, by Guthold and colleagues (2008) used the data from the 2002-2003 World Health Survey, which included 51 countries, the majority of which were part of the developing world. The third study analysed the prevalence of physical activity in 20 countries (Bauman, Ainsworth, et al., 2009; Bauman, Bull, et al., 2009). The overall sample included data from 76 countries including low-, middle- and high-income nations. These three studies utilised the International Physical Activity Questionnaire (IPAQ) to assess the levels of physical activity, so cross-country comparisons were possible.

Dumith and colleagues' (2011) analysis showed that the overall prevalence of physical inactivity in 76 countries was 21.4% (17.4% after weighing for the total population of each country). The pooled results of these three multi-centred studies indicated that physical inactivity was higher in wealthier countries and among women and elderly individuals. Gender differences in physical activity prevalence were even more evident in low-income countries (Dumith et al., 2011).

2.3.2 The economic impact of physical inactivity

Physical inactivity is an important public health issue also because of its economic impact on the healthcare system. There are direct and indirect costs associated with physical inactivity. Direct costs are the direct medical healthcare costs and include, for example, the number of hospitalisations, doctor visits, drugs, etc., to treat specific diseases associated with physical inactivity (e.g., cardiovascular diseases, diet and obesity-related chronic diseases). Indirect costs include the economic loss due to illness, injury-related work disability, or premature death (Popkin, Kim, Rusev, Du, & Zizza, 2006).

2.3.2.1 Direct medical costs

In developed countries, it is estimated that the direct healthcare costs due to physical activity range from 1.5% to 3.0% of total healthcare costs and this affects public and private healthcare systems (Oldridge, 2008). For example, in the United States, a cross-sectional stratified analysis of the 1987 U.S. National Medical Expenditure Survey (Pratt, Macera, & Wang, 2000) revealed that physically active people, aged 15 and older, without physical impairments, had on average lower medical costs as opposed to people who were inactive. In fact, the average annual direct medical cost of active people was $1,019 and $1,349 for those who reported not being active (Pratt et al., 2000). Moreover, medical costs were lower among those who were physically active and did not smoke ($953 per year). Brownson, Boehmer and Luke (2005) reported that the total impact on medical costs due to inactivity and its consequences was $76 billion in 2000 (Brownson et al., 2005, p. 421).

Garrett et al. (2004), studied a population living in the state of Minnesota, USA, and subscribed to a large health plan (Blue Cross Blue Shield), reported that the total medical expenditures due to physical inactivity were $83.6 million (Garrett, Brasure, Schmitz, Schultz, & Huber, 2004). In another study, which combined the results of two national surveys (the 1996 Medical Expenditure Panel Survey and the 1995 National Health Interview Survey), Wang and colleagues (2004) found that in 1996 that physical inactivity accounted for 13.1% ($5.4 billion) of the total medical expenditure of people diagnosed with cardiovascular diseases. Projecting these percentages to the total health and economic burden of cardiovascular diseases in 2001, the direct medical expenditure reached $23.7 billion, associated to 9.2 million cases (Wang, Pratt, Macera, Zheng, & Heath, 2004). Similar estimates were produced by Colditz (1999) who reported that physical inactivity alone cost approximately $24 billion to the healthcare system, corresponding to the 2.4% of the total U.S. healthcare expenditures in 1999.

In Canada, the direct healthcare costs of physical inactivity in 1999 were estimated to be about $2.1 billion, or 2.5% of the total direct healthcare costs (Katzmarzyk, Gledhill, & Shephard, 2000). However, only two years later, the economic burden of physical inactivity rose to an estimated $5.3 billion ($1.6 billion in direct costs and $3.7 billion in indirect costs). The total economic costs of physical inactivity and obesity represented 2.6% and 2.2%, respectively, of the total healthcare costs in Canada in 2001 (Katzmarzyk & Janssen, 2004). A study with a Chinese population estimated that the costs for the direct dietary and physical activity effects were more than $4.7 billion in 2000, and were projected to remain stable until 2050, when it is estimated that they will be about $4.3 billion (Popkin et al., 2006).

In Australia, a recent report by the Australian health insurance company Medibank estimated that in 2007 the total gross cost of physical inactivity was $1.5 billion a year in terms of healthcare expenditures for the prevention, diagnosis and treatment of medical conditions (Medibank, 2007). Of the total direct cost, $468.7 million were costs related to falls, and $371.5 million to Coronary Heart Disease due to physical inactivity (Medibank, 2007, p. 5). In 2008, the estimated total gross cost was $1.6 billion (Medibank, 2008, p. 6). Moreover, regarding the costs projected on the whole economy, Medibank and KPMG-Econtech estimated that inactivity caused a loss of $9.3 billion in GDP.

In Europe, physical inactivity was associated with high financial costs in various countries across the region, according to the 2006 WHO report on *Physical activity in Europe* (Cavill et al., 2006). It was estimated that physical inactivity cost a country about

€150 – €300[1] per European citizen per year (Cavill et al., 2006). For example, in Switzerland, a country with a private-based healthcare system, a study by Martin and colleagues (2001) showed that physical inactivity accounted for 1.6 billion Swiss francs per year.

In England, the Department of Culture, Media and Sports (DCMS) estimated that physical activity accounted for at least £2 billion a year (DCMS, 2002). Allender, Foster, Scarborough and Rayner (2007) estimated that in 2002, physical inactivity impacted on the NHS costs of £1.06 billion[2]. In 2006, Cavill and colleagues (2006) estimated that the annual costs (including direct and indirect costs) to the National Health Service (NHS) ranged between €3 and €12 billion (Cavill et al., 2006, p. 7). It was also underlined that this estimated costs “excludes the contribution of physical inactivity to overweight and obesity, whose overall cost might run to €9.6-10.8 billion per year” (Cavill et al., 2006, p. 7). More up-to-date estimates, published in the *Be active, be healthy: a plan for getting the nation moving* of the Department of Health, showed that the annual costs to NHS due to physical inactivity ranged between £1 and £1.8 billion (DH, 2009, p. 14).

2.3.2.2 Indirect costs of physical activity

In 2011, the World Health Organization (WHO) estimated that the indirect costs of physical inactivity consisted of about 3.2 million deaths per year globally (WHO, 2011a, p. 1, 2011b, para. 2). In the 2001 WHO World Health Report it was estimated that the indirect costs of physical inactivity were “1.9 million deaths and 19 million Disability Adjusted Life Years (DALYs) globally (WHO, 2002, p. 61). DALYs include the sum of years of potential life lost due to premature mortality and the years of productive life lost due to disability.

[1] This range corresponds to approximately \$190.74 – \$381.48 (1 EUR = 1.27160 USD; 1 USD = 0.786410 EUR) and to CHF 182.17 - 364.35 (1 EUR = 1.21451 CHF; 1 CHF = 0.823380 EUR), according to mid-market rates for: 7/1/2012.

[2] This translates in approximately \$1.63 billion (1 GBP = 1.54251 USD; 1 USD = 0.648294 GBP) or CHF 1.56 billion (1 GBP = 1.47325 CHF; 1 CHF = 0.678771 GBP), according to mid-market rates for: 7/1/2012.

In the United States, Brownson and colleagues (2005) estimated that the annual indirect cost ranged from 200,000 to 300,000 healthy lives in 2000. In Canada, Katzmarzyk and colleagues (2000) estimated that in 1995, 21,000 lives were lost due to physical inactivity. Within the European region, the UK Department of Culture, Media and Sports (DCMS) estimated that 54,000 lives a year were lost prematurely due to physical inactivity (DCMS, 2002). Allender, Foster, Scarborough and Rayner (2007) estimated that in 2002, physical inactivity was directly responsible for the loss of 3% of DALYs in the UK. The cost for the whole economy in terms of productivity is estimated to be about £5.5 billion (due to sickness absence) and £1 billion from premature death of people of working age. In total, these costs reach approximately £8.3 billion every year (DH, 2009, p. 15). For example, in Switzerland, physical inactivity accounted for 1.4 million disease cases, almost 2,000 deaths, and indirect costs of .8 billion Swiss francs (Martin et al., 2001).

All these data suggest that promoting and encouraging physical activity is important also for reducing health-related costs. If people became more physically active, the direct and indirect costs could be significantly reduced. For example, Powell and Blair (1994) estimated that mortality due to sedentary living associated with coronary heart diseases, colon cancer and diabetes, could be reduced by 5-6% per year (30,000-35,000 deaths), if people become moderately active (Powell & Blair, 1994). In economic terms, a 10% of reduction in the prevalence of physical inactivity could result in savings of about $150 million per year in direct health care expenditures (Katzmarzyk et al., 2000, p. 1438).

2.3.3 Factors influencing physical activity

Physical activity behaviour, like other behaviours, is influenced by a wide range of factors. Generally, factors influencing any behaviour can be seen as internal, unchangeable and pre-determined (e.g., gender, social class, gene inheritance), internal and changeable (e.g., attitudes, beliefs, skills, expectations, etc.), or dependant on external or exogenous factors (e.g., social and physical environment).

The relationship between physical activity and the aforementioned factors can be investigated through correlations (i.e., factors that are positively or negatively associated with physical activity), or through causal relationships, where the researcher theoretically identifies causes or predictors of physical activity. If the causal relationship between a factor and physical activity is investigated, then it is more appropriate to talk about 'determinants' instead of correlates. In fact, determinants are those factors that are "followed systematically by variations in physical activity behaviour" (Bauman, Sallis, Dzewaltowski, & Owen, 2002, p. 6).

In terms of correlates of physical activity, various results were found. For example, French, Story, and Jeffery (2001), found that physical activity was negatively associated with time spent in front of television and computer during leisure-time. The use of automobiles for transportation reduced job-related physical activities and the increase in more sedentary jobs and in the presence of labour saving devices (e.g., riding-lawnmowers, snow throwers, and leaf-blower) reduced the effects of physical activity. They also found that proximity to parks and recreational areas could increase the likelihood that people engaged in physical activity. Plotnikoff and colleagues (2004) studied the relationship between age, gender, and urban-rural differences in physical activity. They discovered that proportion of friends who exercise and perceived health status were positively highly correlated with physical activity, whereas personal history of injuries during past physical activity, the level of education, and alcohol consumption were negatively highly correlated with physical activity.

In terms of determinants of physical activity, in Dishman, Sallis and Orenstein' seminal review (1985), they identified three main categories of determinants: a) characteristics of the activity itself (physical activity type); b) characteristics of the person and individual lifestyle habits, c) environmental characteristics. These characteristics were also related to the participation in physical activity or exercise programmes.

2.3.3.1 Influence of physical activity type

Early investigations about the determinants of physical activity found that certain types of physical activities (i.e., vigorous activities and the consequences of high training, such as stress-induced injury) tended to create larger dropouts in participants, as opposed to lifestyle activities (Dishman & Sallis, 1994; Dishman et al., 1985; Paffenbarger et al., 1990). In fact, routine physical activity did not differ between genders and between different age groups. However, men and younger adults tended to be much more likely to engage in vigorous activities than women. Moreover, Dishman et al. found out that prior participation in physical activity can encourage or discourage subsequent participation and increase the chances of drop-out (Dishman et al., 1985). Furthermore, participation in physical activity was found to be hindered by perceived discomfort during exercise, suggesting that negative experiences among people who do not practice exercise routinely may discourage them to continue (Sherwood & Jeffery, 2000).

2.3.3.2 Individual or personal characteristics

Among the individual characteristics, Dishman and colleagues (1985) included past or present knowledge, attitudes towards the behaviour, actual behaviours, personality traits, and biomedical (e.g. body composition and weight) and demographic variables (e.g. gender, social status, cultural group membership). The authors reported evidence about participation in programmes where activity could be directly observed which showed that *past participation* was the most reliable correlate of current participation for both genders and for patients with coronary heart disease and obesity problems. For spontaneous participation in physical activity, participation in exercise and sports in young age was found to be highly correlated with engagement in activities in the adult age.

Among biomedical and demographic characteristics, Dishman et al. reported that, for example, blue-collar workers and smokers were more likely to drop out from cardiac rehabilitation programmes. Additionally, men at risk of cardiovascular disease were not likely to enter a programme. In general, people who were not interested in health or perceived their health status as poor were unlikely to participate in health programmes (Dishman et al., 1985). Similar results were found in a more recent study by Chinn and colleagues (2006) on factors influencing participation in a physical activity promotion trial. They found that male, smokers and those residing in more deprived areas were less likely to engage in physical activity (Chinn, White, Howel, Harland, & Drinkwater, 2006). A systematic review by Kaewthummanukul and Brown on the determinants of participation in a workplace promotion programmes (2006), revealed that women, blue-collar workers and individuals with higher education were on average more sedentary than men, white collar workers and individuals with lower education respectively (Kaewthummanukul & Brown, 2006). Also official data showed that on average women tended to be less active than men. For instance, Crespo and colleagues (1999) found that gender and social class were important determinants of physical activity: men were more active than women, and those less educated who lived below the poverty line were less likely to be active. Some studies showed also that when women become mothers they tend to become less physically active. For example, Gaston and Cramp (2011), in their review on changes in physical activity pre- and post- pregnancy, confirmed that pregnant women tend to be less active than before pregnancy. Moreover, they identified that having a higher education and income, being white, not having other children in the home, and being more physically active prior to pregnancy were the strongest predictors of exercise during pregnancy.

In a recent systematic review on determinants of change in physical activity among young people aged 14 to 18 years, Craggs and colleagues (2011) discovered that gender and age were important determinants of physical activity. Among children aged 4-9 years, girls reported larger declines in physical activity levels than boys. Among those aged 10-13 years, higher levels of previous physical activity and self-efficacy resulted in smaller declines. Among adolescents (aged 14-18 years), the role of cognitive determinants and social norms become more influential: those who had higher perceived behavioural control, received support for physical activity, and had higher levels of self-efficacy reported smaller declines in physical activity (Craggs, Corder, van Sluijs, & Griffin, 2011).

Similar patterns were found in studies involving participants of different age groups and throughout the life course. For example, Bianchini de Quadros and colleagues (2009) discovered that female students were 1.69 times more likely to be physically inactive than men, and that students following classes at night were 1.70 more likely to present physical inactivity than those enrolled in day-courses. Another study with a student population in Hong Kong found that being female, not residing on the campus, and with poor or very poor health status were predictors of physical inactivity (Abdullah, Wong, Yam, & Fielding, 2005). Among working age adults, a systematic review of the literature published between 1990 and 2002 revealed that self-efficacy and the belief in personal ability to perform physical activity were the best predictors of physical activity, as well as perceived benefits and perceived health status (Kaewthummanukul & Brown, 2006). Among older adults, Booth et al. (2000) found out that gender was a predictor of physical activity, with males being more physically active than females (Booth, Owen, Bauman, Clavisi, & Leslie, 2000).

Other examples of individual-level determinants of participation in physical activities across age groups include time availability (Abdullah et al., 2005; Brownson, Baker, Housemann, Brennan, & Bacak, 2001; Tavares & Plotnikoff, 2008; Trost, Owen, Bauman, Sallis, & Brown, 2002) motivation (Brownson et al., 2001; Piko & Keresztes, 2006), and social support, especially the support provided by friends or family, among younger populations (Booth et al., 2000; Leslie et al., 1999; Piko & Keresztes, 2006). Among working age adults, the principal determinants of participation in physical activity include having opportunities to exercise in the workplace (Brownson et al., 2001), or not feeling too tired to exercise (Brownson et al., 2001). There are also socio-cognitive determinants of participation in physical activity for employees. According to

Kaewthummanukul and Brown, these include self-efficacy or perceived control over behaviour, motivational readiness to engage in physical activity, perceived health status, and perceived health benefits of physical activity (Kaewthummanukul & Brown, 2006). The role played by other socio-cognitive determinants of physical activity behaviour and related to the Theory of Planned Behaviour are discussed in paragraph 2.7.

2.3.3.3 Influence of environmental factors

Physical activity is related to environmental characteristics in many ways. For example, being close to sidewalks, playgrounds, walking paths, sports facilities distance can facilitate participation in physical activities indoors or outdoors. In addition to the early investigations of Dishman and colleagues, many more recent studies analysed the association of the built environment with physical activity (e.g., Berke, Koepsell, Moudon, Hoskins, & Larson, 2007; Foster & Hillsdon, 2004; Owen, Humpel, Leslie, Bauman, & Sallis, 2004; Popkin, Duffey, & Gordon-Larsen, 2005; Saelens & Handy, 2008; Sallis & Glanz, 2006).

The built environment can be defined as a multidimensional concept, which broadly includes patterns of human activity at various scales of geography within the physical environment. According to Handy and colleagues (2002), the built environment is a combination of elements including: 1) urban design (i.e., the design of a city and its physical elements); 2) land use, location and density of residential, commercial, industrial, forest, and others; and 3) transportation system, physical infrastructure of roads, sidewalks, bike paths, and others.

Among the environmental factors that can be considered strong predictors of physical activity, there is proximity (or distance) from the places where physical activity occurs (Saelens & Handy, 2008). For example, Reed and Phillips studied the effect of distance or proximity from the exercise site in a university student population (Reed & Phillips, 2005). They showed that the higher the distance, the less likely physical activity occurred. Similarly, other studies found that finding footpaths safe for walking and ease of access to local facilities were predictors of physical activity (Booth et al., 2000).

Berke and colleagues (2007) discovered that older adults aged 65 to 97 years, living close to a built environment with walking paths, engaged in walking more often and were less obese than those living in areas where walking was more difficult (Berke et al., 2007). Also Owen and colleagues (2004) found that the presence and availability of footpaths, trails, the accessibility of places to walk to (i.e., shops, beach), and the reduced level of traffic on roads were all significantly and positively associated with increased levels of specific types of walking for exercise, recreation and total walking.

Among other environmental determinants of physical activity, several reviews showed that the aesthetic nature of the environment (i.e., the attractiveness) had positive effect on physical activities, especially walking (Humpel et al., 2002; Owen et al., 2004; Saelens & Handy, 2008). Additionally, Brownson and colleagues (2001) discovered that enjoyable scenery and presence of hills were positively associated with physical activity, whereas, conversely, living in deprived areas was negatively associated with physical activity (Chinn et al., 2006).

2.4 Strategies and approaches to promote physical activity

The evidence of the benefits of physical activity and the trends towards less activity in the population made it clear that it was necessary to develop and implement preventive action-oriented strategies in order to address the problem in strategic and systematic approaches. Since the end of the 1990s, physical activity was recognised as global public health imperative (Sparling et al., 2000). For example, in 1996, the U.S. *Report of the Surgeon General* included a list of public health recommendations that could be translated into strategies. In particular, the panel of experts identified four main strategic areas where public health interventions to encourage physical activity should have been developed: a) school-based programmes, b) counselling by health care providers, c) worksite activity programmes, and d) built-environment (USDHHS, 1996, p. 3). A few years later, physical activity was listed among the leading priorities and health indicators of Healthy People 2010, a 10-year agenda for improving the nations' health by developing research-based goals and objectives for health promotion and disease prevention. The Healthy People 2010 agenda published in the early 2000s, included physical activity among the leading health priorities for the nation (USDHHS, 2001). Reducing the proportion of adults who do not engage in leisure-time physical activity remains one of the main objectives of the updated agenda, Healthy People 2020 (USDHHS, 2011).

In the same direction, several health organisations and governmental institutions (e.g., WHO, the United Nations, WCRF/AICR, European Commission, and many more) published, in the last decade, numerous reports and policy documents that urge member countries and organisations in various sectors and levels to collaborate and actively respond to the problem of physical activity. For example, the 2011 UN General Assembly high-level meeting on NCD prevention and control provided all stakeholders an opportunity to highlight the important impact physical activity and sport can have on the health of young people (WHO, 2010). The United Nations consider physical activity as "the least expensive and most effective preventive 'medicine' for combating the increasing worldwide problem of obesity and, with physical fitness, may represent the most effective strategy to prevent chronic disease" (UN, 2011, para. 8). This might explain why sport has been recognised as a viable and practical tool to assist in the achievement of the millennium development goals (MDGs) because "it can be very effective when part of a broad, holistic approach to addressing the MDGs" (UN, 2010, para. 2).

2.4.1 The World Health Organisation's Global Strategy

The WHO *Global Strategy on Diet, Physical Activity and Health* is considered an important milestone for the development of health promotion programmes focusing on physical activity and diet (Bauman & Craig, 2005; Brown & Bell, 2007; Waxman, 2004, 2005; Waxman & Norum, 2004). The strategy was not perceived as prescriptive and proposed a comprehensive range of policy options to member states to choose (Waxman & Norum, 2004). The goal of the Global strategy was to support member states in their efforts to reduce the impact of morbidity, disability and premature mortality associated with noncommunicable diseases. Its objectives were to map the epidemics related to these diseases, to reduce the exposure to common risk factors (i.e., tobacco abuse, unhealthy diet, physical inactivity and their determinants), to strengthen health care and develop norms and guidelines for cost-effective interventions, with priority given to cardiovascular diseases, cancer, diabetes and chronic respiratory diseases. According to the document, these objectives would have been achieved by means of surveillance programmes, promotion and prevention initiatives, appropriate health care innovations and coordinated health sector management efforts, with WHO playing a supporting and coordinating role.

The requested strategy was formally endorsed during the 57th World Health Assembly, in May 2004 (WHO, 2004). The *Global Strategy on Diet, Physical Activity and Health* was the outcome of a long process involving extensive consultations and meetings with numerous stakeholders: 81 countries in 6 regional consultations, 11 UN agencies, 22 international nongovernmental organisations, 25 international industry associations, Expert Reference Group, CEOs and senior executives with 13 international companies and 13 international NGOs (Keller, 2005), included the expertise and advice of United Nations (Food and Agricultural Organisation), and by an Expert Reference group of prominent experts, which provided scientific and policy input (Waxman & Norum, 2004).

The adoption of a global strategy was favourably acknowledged by the scientific and public health communities, as it was seen as "a unique opportunity in the history of international physical activity work, as the development of common frameworks, policies and programs would enable greater program opportunities and partnerships at the national level" (Bauman & Craig, 2005, p. 4). One of the key elements of this strategy was its multi-sectorial approach (Tukuitonga & Keller, 2005; Waxman, 2004; Waxman & Norum, 2004), because it involved policies at different levels (Waxman & Norum, 2004). This approach addressed physical activity in all aspects of life (work, home and school), and was aimed at impacting the built environment, which included aspects of city planning, urbanisation and transportation, safety and access to physical activity during leisure-time.

For Governments, the suggestions were to promote policies through education and public awareness campaigns and adult literacy programmes, which utilised clear, positively framed and simplified messages (Keller, 2005; Tukuitonga & Keller, 2005). These messages should discourage unhealthy dietary practices or physical inactivity, and "education, communication and public awareness initiatives should be put into place in order to communicate through several channels and in forms appropriate to local culture, age and gender" (WHO, 2004, p. 7). The Global strategy document stressed also that "behaviour can be influenced especially in schools, workplaces and educational and religious institutions, and by nongovernmental organisations, community leaders and mass media" (WHO, 2004, p. 7).

To achieve the objectives of the strategy and in order to translate the Global Strategy for the Prevention and Control of Noncommunicable Diseases into concrete action, the WHO developed the 2008-2013 Action Plan (WHO, 2009). The goal of the plan was to provide guidelines to implement national guidelines on physical activity for health, and population-wide programmes in line with WHO initiatives. Additionally, the Action Plan aims at fostering the creation of school-based programmes, physical environments for safe active commuting, and spaces for recreational activity. The plan aimed also at introducing transport policies that promote active and safe methods of travelling to and from schools and workplaces; improving sports, recreation and leisure facilities; and increasing the number of safe spaces available for active play (WHO, 2009b).

2.4.2 Global collaborations for effective strategies

The principles and ideas contained in the WHO Global Strategy on Diet, Physical Activity and Health, were endorsed by many other international institutions (i.e., the United Nations, CDC, WCRF/AICR, European Commission), which continue to propose, at least on official documents, collaborations and partnerships at various levels.

For example, in the report *Harnessing the Power of Sport for Development and Peace: Recommendations to Governments* (SDP IWG, 2008), the United Nations Sport for Development and Peace International Working Group encouraged Member States to implement various policy interventions, in line with the WHO Global Strategy principles. In particular, the SDP IWG urged to develop comprehensive evidence-based strategies which address physical, social and environmental barriers to increase physical activity in populations. To understanding and promoting physical activity a holistic approach was recommended, and this view follows the WHO multi-level perspective.

Similar efforts were conducted at the European level, starting from the early 2000s. In 2003, the European Commission established a Network on Nutrition and Physical Activity (NPA), composed of experts nominated by the Member States, the World Health Organisation (WHO) and representatives of consumer and health NGOs, to advise on the development of a European strategy on nutrition and obesity (European Commission, 2011b). In 2005, the European Commission officially founded a *European Platform for action on diet, physical activity and health* with the aim to develop best practices and foster actions to promote health and contain current trends (European Commission & others, 2005; European Commission, 2011b). The fields for action identified so far by the current actors in the Platform reflected the various experiences of participants and include consumer information, health education and physical activity promotion (European Commission & others, 2005, p. 2). The importance of collaboration among different stakeholders was further emphasised: “It is an important development whereby the EU is facilitating the contributions from various interested stakeholders towards the achievement of the objectives of the Global Strategy on Diet, Physical Activity and Health” (Tukuitonga & Keller, 2005, p. 124).

The WHO Global Strategy is often cited as point of reference in many other strategic documents produced by other international organisations. Recent examples include the International Society for Physical Activity and Health (ISPAH) and the International Olympic Committee (IOC). The International Society for Physical Activity and Health (ISPAH) launched, in May 2010, a global call to action in the *Toronto Charter for Physical Activity* (ISPAH, 2010). The Toronto Charter suggested that governments, NGOs, academic institutions, professional associations, and the private sector to adopt policies and interventions promoting physical activity. These actions were supposedly meant to follow principles consistent with the WHO Global Strategy on Diet, Physical Activity and Health (WHO, 2004). Indeed, the Toronto Charter stresses the interventions to address the environmental, social and individual determinants of physical inactivity, as well as developing national policies and action plans, increasing funding for physical activity promotion in the workplaces and develop partnerships for action (ISPAH, 2010, p. 3).

In 2011, the International Olympic Committee (IOC) endorsed actions and collaborations with the WHO offices to foster physical activity and sport and produced a consensus statement with recommendations for sport organisations, governments, NGOs, and research institutions (Mountjoy et al., 2011). The IOC stressed the role of international physical activity networks, Agita Mundo is the global network for physical activity promotion and GAPA acts as the advocacy council of the International Society for Physical Activity and Health. In the Americas, the regional physical activity promotion networks are RAFA/PANA. In Europe, there is the European Network for the Promotion of Health-enhancing Physical Activity (HEPA) in Asia-Pacific, there is the

Physical Activity Network and in Africa, the African Physical Activity Network (Mountjoy et al., 2011).

2.4.3 Primary and secondary prevention approaches

To address health risk factors and to translate the strategic plans into action, two main approaches are used in physical activity interventions: primary prevention and secondary prevention approaches. Primary prevention approaches aim at reducing risks of the entire population without considering the individual's level of risk and potential benefits (Proper & van Mechelen, 2008). Primary prevention is based on the principle that even small changes in the large majority of a low-risk population might have an overall big impact in terms of population-attributable risks of death and disability (WHO, 2003).

The secondary prevention approach focuses on screening and providing treatment to populations at high-risk of developing diseases or that have already developed sub-clinical illnesses (Proper & van Mechelen, 2008). Secondary prevention can be effective if the disease process is reversible, effective treatments are available and if accurate screening is undertaken (WHO, 2002). According to Proper and van Mechelen, this approach can be effective in reducing the costs at the population level, because the interventions are provided to a few people, but "it might also increase the costs of identifying the group of people most likely to benefit" (Proper & van Mechelen, 2008, p. 17).

In general, primary intervention approaches seem to be more appealing for public health initiatives than secondary approaches, as primary approaches are aimed at larger segments of population and even small changes at individual level would lead to bigger changes at a population level (WHO, 2002b, 2007). In the development of public policies for preventing diseases a combination of different actions in different settings is needed in order to reach the appropriate target populations. Strategies deemed "effective" involve interventions at various levels and settings. These might include mass media campaigns, policy and environment changes, school settings, workplace programmes, and community and primary healthcare (Bellew, Bauman, Martin, Bull, & Matsudo, 2011).

According to the U.S. Task Force on Community Preventive Services[3] (USPSTF, 2005), which reviewed the evidence about health promotion interventions, three types of approaches in promoting behaviour change are recommended: 1) informational approaches, 2) behavioural and social, individually adapted approaches; 3) environmental and policy approaches. Informational approaches aim to change knowledge and attitudes about the benefits of and opportunities for physical activity within a community. Among informational approaches, mass-media campaigns and classroom-based health education focusing on providing information showed weak evidence of effectiveness, suggesting that information alone is not enough for effectively changing behaviour (USPSTF, 2005). However, according to a systematic review by Kahn et al. (2002), two types of informational interventions were deemed more effective than others: 'point-of-decision' prompts, for example, to encourage stair use, and community-wide campaigns for encouraging physical activity (Kahn et al., 2002). Mass-media campaigns were not found as effective as individually-tailored or community wide interventions. A unique example of an effective social marketing mass-media campaign promoting physical activity was the VERB™ Campaign in the U.S., which ran from 2002 to 2005 (Banspach, 2008; Berkowitz, Huhman, Heitzler, et al., 2008; Berkowitz, Huhman, & Nolin, 2008; Bretthauer-Mueller et al., 2008; Collins & Wechsler, 2008; Huhman et al., 2007; Wong, Greenwell, Gates, & Berkowitz, 2008). This campaign, developed by the Centers for Disease Control and Prevention (CDC), targeted mainly tweens (aged 9-13 years) and used commercial marketing methods to promote an active lifestyle. The campaign expanded its reach also to children's parents and minorities (Huhman, Berkowitz, et al., 2008; Price, Huhman, & Potter, 2008). The VERB™ Campaign was deemed effective in influencing children's behaviour. Studies evaluating the campaign outcomes revealed that there was a significant dose-response effect of exposure to VERB on the children reporting physical activity: the more children were

[3] The U.S. Preventive Services Task Force (USPSTF) "represents one of several efforts by governments and national organizations to take a more evidence-based approach to the development of clinical practice guidelines" (Harris et al., 2001, p. M15).

exposed to VERB, the more they engaged in activities and the more positive were the attitudes towards it (Bauman et al., 2008; Berkowitz, Huhman, & Nolin, 2008; Huhman et al., 2007; Huhman, Bauman, & Bowles, 2008). This campaign could count on an unprecedented large and sustained investment by the U.S. Congress (about $340 million over the period 2001-2005[4]). One of the reasons for the success of this campaign is that the VERB™ Campaign "leveraged high brand awareness through the development and promotion of VERB activities in places that are important in children's lives (e.g., schools, community organizations, family/parents, commercially sponsored events, print materials, and Internet sites)" (Banspach, 2008, p. S275).

Behavioural approaches are aimed at influencing individual's behaviours for example by teaching skills useful to adopt and maintain certain behaviours or by motivating people towards change. Among behavioural and social approaches to increasing physical activity, the recommended interventions involve school-based physical education, individually adapted health behaviour change programmes, and social support interventions in community settings (Kahn et al., 2002; USPSTF, 2005). Individually-centred behavioural interventions fall within a primary prevention approach, as they are aimed at directly influencing individual's behaviour or at changing the environment around the individual, so that change is more likely to happen. Several systematic reviews showed that individually adapted health behaviour change programmes were effective in increasing levels of physical activity, as measured by different indices, including increase in the percentage of people engaging in physical activity, energy expenditure, or other physical activity measures (Foster, Hillsdon, & Thorogood, 2005; Kahn et al., 2002; Pelletier, 2009). Also community based interventions aimed at encouraging physical activity showed promising results in behaviour change, as testified by numerous other systematic reviews (Baker, Francis, Soares, Weightman, & Foster, 2011; Bopp & Fallon, 2008; Foster et al., 2005; Kahn et al., 2002; Roux et al., 2008; USPSTF, 2002).

[4] The investment in the 2001 fiscal year was $125 million, $68.4 million in FY 2002, $51.3 million in FY 2003, $36 million in FY 2004, and $59 million in FY 2005 (Wong, Greenwell, Gates, & Berkowitz, 2008, p. S175).

Environmental and policy approaches are aimed at physically changing the structure of the built environment or to enforce laws that provide safe, attractive and convenient venues for physical activity (Kahn et al., 2002). Among environmental and policy approaches, the recommended interventions involve the creation or the enhancement of places for physical activity combined with informational outreach activities (Kahn et al., 2002; USPSTF, 2005). The role of environmental changes and ecological approaches has been put forward by various authors who arguably support the implementation of comprehensive strategies for health promotion, especially in settings such as the workplace or communities (Bennie, Timperio, Dunstan, Crawford, & Salmon, 2010; Brownson et al., 2001; Engbers, van Poppel, Chin A Paw, & van Mechelen, 2005; French et al., 2001; Humpel, Owen, & Leslie, 2002; Matson-Koffman, Brownstein, Neiner, & Greaney, 2005; Pelletier, 2005; Popkin et al., 2005; Sallis, Bauman, & Pratt, 1998).

2.4.4 The role of communication

The examples and strategies provided so far can be seen from a broad communication point of view, because each strategic plan, to be effectively implemented, needs to be communicated. Generally, a plan needs to be transferred to each partner and stakeholder before being communicated to the final recipient. In fact, public health strategic goals and objectives need be translated into specific interventions, campaigns or initiatives, which need to be promoted and communicated, using the most suitable and appropriate means of communication, channels, messages, language, etc. In this sense, communication, and more specifically health communication stands at the core of effective public health initiatives (Bernhardt, 2004). In Healthy People 2010, health communication was listed among one of the key focal areas for promoting health. Health communication is defined as the “art and technique aimed at informing, influencing, and motivating individual, institutional, and public audiences about important health issues. […] The scope of health communication includes disease prevention, health promotion, health care policy, and the business of health care as well as enhancement of the quality of life and health of individuals within the community" (USDHHS, 2000, p. 20). From this perspective, the strategies and examples of initiatives presented in this paragraph provide further conceptual, theoretical and practical elements to the framework and rationale of this dissertation.

2.4.5 Physical activity: a governmental priority in the UK

As previously mentioned, the estimated prevalence of physical inactivity in the UK was above 63% as of 2008 (WHO, 2011e, 2011f). Moreover, according to 2009 Health Profile of England, the prevalence of adult obesity in England is among the highest in the European Union, with levels increasing over time (DH, 2010a). The NHS estimated that in 2009, 38% of adults had a raised waist circumference in 2009 compared to 23% in 1993. Moreover, 22% of men and 24% of women aged 16 or over were classified as obese (NHS, 2011). In line with WHO's estimates of noncommunicable risk factors (WHO, 2009a, 2011a), poor diet as well as alcohol consumption, smoking and physical inactivity, are considered leading behavioural risk factors in the UK and these factors have large impact on NHS budget. Allender and colleagues (2007) estimated that in 2002 physical inactivity was directly responsible for 3% of morbidity and mortality in the UK and the estimated direct cost to the NHS was £1.06 billion. In 2009, the Department of Health reported that the average cost of physical inactivity for NHS Primary Care Trusts (PCTs) was £5 million every year per PCT (DH, 2010a). Updated statistics for the years 2006-2007, estimated that the costs for physical activity were about £0.9 billion and for overweight and obesity were £5.1 billion (Scarborough et al., 2011). In 2011, the Chief Medical Officers issued a general report on the health of the country *Start active, stay active* (DH, 2011a), which accompanied the first set of physical activity recommendations specifically adapted for the UK population (DH, 2011a).

For their impact on society at large and on economy, physical activity and healthy diet are considered major government priorities. The attention towards these health issues is testified by several reports, guidance documents, policies and white papers, published in the last eight years. For instance, a fundamental document with these regards is the 2004 public health white paper *Choosing health: making healthier choices easier* (DH, 2004), which was supported by the Government of Prime Minister Tony Blair. In the foreword Tony Blair explained the government's vision through the policy document: "Choosing health sets out how we will work to provide more of the opportunities, support and information people want to enable them to choose health. It aims to inform and encourage people as individuals and to help shape the commercial and cultural environment we live in so that it is easier to choose a healthy lifestyle" (DH, 2004).

The strategy outlined in the white paper was followed by two subsequent action plans on physical activity (DH, 2005a) and on diet (DH, 2005b). In particular, the *Choosing activity action plan* (DH, 2005a) contained, among other general strategic principles, indications of a social marketing strategy aimed at informing different target groups and settings on obesity, healthy eating and physical activity.

In 2009, the Department of Health issued another policy document: *Be active, be healthy* (DH, 2009a). This document established a "new framework for the delivery of physical activity alongside sport for the period leading up to the London 2012 Olympic Games, Paralympic Games and beyond. Programmes outlined in the plan will contribute to Government's ambition of getting 2 million more people active by 2012" (DH, 2009a, p. 5). The *Be active* policy included the advices and recommendations of the National Institute for Health and Clinical Excellence (NICE) for *Promoting and creating built or natural environments that encourage and support physical activity* (NICE, 2008). The policy included also a list of objectives for fostering partnerships with various stakeholders (i.e., Sport England, NHS, other departments) with the aim to establish new opportunities for promoting physical activity. Among these, a physical activity policy for a specific target audience is the 'Physical Activity Care Pathway', a Pilot for the 'Let's Get Moving' policy, which targeted NHS staff (DH, 2009b). Physical Activity Care Pathway is a systematic approach to integrating physical activity promotion into the primary care setting (Boehler, Milton, Bull, & Fox-Rushby, 2011).

The *Be active* policy document mentioned cycling or walking schemes (i.e., Walking the Way to Health), swimming programmes, and more comprehensive movements such as '*Change4Life*' (and its related brand extensions *Walk4Life* and *Bike4Life*). *Change4Life*, launched at the beginning of 2009, is an important example of a society-wide movement aimed at encouraging families to become more physically active, eat well and live longer. Change4Life is part of a broader strategy outlined in the *Healthy Weight, Healthy Lives cross-governmental strategy* (DH, 2008) and in *Healthy Weight, Healthy Lives: One Year On* (DH, 2009c). Change4Life is an example of a long-term and comprehensive social marketing strategy (DH, 2011c; Mitchell, Clifford, Hardy, & Asscher, 2011), which seems to have borrowed some elements of success (i.e., branding, use of mass media, partnerships) from the successful VERB™ Campaign. Initial evaluation of the movement showed encouraging results, with families actively engaging in the proposed behaviours (DH, 2010b). Change4Life was initially funded with £75 million in the first year, but due to the global financial crisis the budget was cut down to £14 for the years 2011-2012 (Mitchell et al., 2011, p. 11). The main implication for this was a redefinition of Change4Life's social marketing strategy, which reflected a general update of a broader social marketing strategy for public health in England (DH, 2011c).

2.5 Workplaces as a setting for health promotion

Among the various settings for interventions, worksites are considered strategic for health promotion by many international institutions and health organisations because they can offer access to a large number of people, considering that more than 60% of the world's population is accessible directly or indirectly through the workplace (Batt, 2009; Blake & Lloyd, 2008). In workplaces employees interact closely and frequently with others, and the population is relatively stable, so that policies can be easily enforced (USPSTF, 2009). The International Labour Organisation (ILO) estimated that, globally, approximately 65% of the population aged over 15 years is part of the workforce and that in 2007, nearly 3.1 billion people were economically active (ILO as cited in WHO/WEF, 2008, p. 7). Updated projection estimates show that the total labour force in 2020 would reach approximately 3.6 billion, which corresponds to the 64.1% of the total predicted population of 5.7 billion (ILO, 2011a, 2011b). In the United Kingdom, about 29.1 million people were employed as of April-June 2011, corresponding to a proportion of about 75% of the whole population (ONS, 2011a).

The importance of health promotion in the workplace has been recognised by the International Labour Organization (ILO) and the World Health Organization (WHO), which established in the 1950s a joint committee specifically focused on occupational health (WHO, 2002b). In the following decades, the WHO and other institutions have emphasised the importance of health promotion in the workplace through many declarations and charters, including the 1986 Ottawa Charter for Health Promotion (WHO, 1986), the 1997 Jakarta Declaration on Leading Health Promotion into the 21st Century (WHO, 1997), and the 2005 Bangkok Charter for Health Promotion in a Globalized World (WHO, 2005b). Workplaces were mentioned also in the Toronto Charter for Physical Activity, in which the Global Advocacy Council for Physical Activity of the International Society for Physical Activity and Health underlined the need to develop and implement policies in the workplace to "support infrastructure and programmes for physical activity and promote active transport to and from work" (ISPAH, 2010, p. 3).

The important role played by workplaces in health promotion was further recognised in other strategic documents such as the aforementioned WHO Global Strategy on Physical Activity and Diet (WHO, 2004), and the WHO Global Plan of Action on Workers' Health 2008-2017 (WHO, 2007a), which were developed in response to the global health priority of noncommunicable diseases prevention (see paragraph 2.3). In the WHO Global Strategy on Physical Activity and Diet it is stated that: "People need to be given the opportunity to make healthy choices in the workplace in order to reduce their exposure to risk. Further, the cost to employers of morbidity attributed to noncommunicable diseases is increasing rapidly. Workplaces should make possible healthy food choices and support and encourage physical activity" (WHO, 2004, p. 14). Also the WHO Global Plan of Action on Workers' Health 2008-2017 (WHO, 2007a), endorsed by the 60th World Health Assembly resolution WHA60.26 (WHO, 2007b), underlined that health promotion interventions for preventive noncommunicable diseases "should be further stimulated in the workplace, in particular by advocating healthy diet and physical activity among workers, and promoting mental health at work" (WHO, 2007a, p. 7). The WHO/WEF report on preventing noncommunicable diseases in the workplace through diet and physical activity further supported the necessity to establish clear goals and implement strategies in the workplace setting (WHO/WEF, 2008).

At the European level, workplace health promotion was supported by several statements published by the European Network for Workplace Health Promotion (ENWHP), established in 1996. Examples of these statements include the 1997 (further updated in 2005) Luxembourg Declaration on Workplace Health Promotion in the European Union (ENWHP, 2005), the 2001 Lisbon Statement on Workplace Health in Small and Medium Sized Enterprises (ENWHP, 2001) and the 2002 Barcelona Declaration on Developing Good Workplace Health Practice in Europe (ENWHP, 2002).

In the same direction are the actions of the U.K. Government towards healthy choices in the workplace. In the action plan *Choosing activity* (DH, 2005), two main and essential goals for promoting physical activity in the workplace were outlined. The first was encouraging employers (in the public, private and voluntary sectors) to engage and motivate staff to be more active, and the second was providing employers with support, such as practical advice and examples of best practice (DH, 2005b, p. 33). In order to achieve the first goal, the action plan proposed the establishment of awards, such as the Business in the Community Healthy Workplace Award, for companies that improved the health and well-being of their employees. For the second goal, the Department of Health suggested to establish networks of collaboration with various partners, governmental departments and with the NHS, to provide assistance and social care at local and national levels and to promote successful practices in the country (DH, 2005b). In addition to this, the U.K. National Institute for Health and Clinical Excellence, encourages and supports initiatives to promoting built and natural environments (NICE, 2008a) and health through the workplaces (NICE, 2008b), by outlining a guidance to develop physical activity promotion programmes targeting physical activity among employees.

This guidance addressed employers, trade unions and public health and professionals in small, medium and large organisations, who have a direct or indirect role and responsibility for improving health in the workplace. In particular, NICE recommended to develop and implement organisation-wide plans or policies to encourage and support employees to be more physically active and published a guidance document tiled *Promoting and creating built or natural environments that encourage and support physical activity* (NICE, 2008a).

As seen in paragraph 2.4.3, in the United Kingdom, promoting health is considered a key governmental priority and the workplace is considered an important setting for achieving overall public health goals (DH et al., 2005; DWP/DH, 2008). In the first and pivotal review on the health of Britain's working age population *Working for a healthier tomorrow*, Dame Carol Black urged Government, healthcare professionals, employers, and trade unions to adopt a new approach to health and work (Black, 2008). Dame Carol Black's review suggested that workplace health promotion was not only a matter of good corporate image and corporate social responsibility, but also a matter of costs and of overall health improvement: "the way in which the workplace affects someone's health and well-being is not simply a medical issue [and] the quality of the experience that someone has in their workplace can also impact on health and well-being" (Black, 2008, p. 57). Moreover, Black stressed the fact that better and healthier workplaces produced more financial results: “companies who have higher levels of staff engagement (as measured by looking at parameters such as employee well-being, line management and team-working) have 13% lower staff turnover, less than half the sickness absence of the UK average” (Black, 2008, p. 59).

An important example for a U.K. nation-wide workplace health promotion programme was the *Well@Work* project, promoted by the NHS and by the British Hearth Foundation. The evaluation analysed 11 initiatives involving 32 organisations and potentially 10,000 employees in the United Kingdom. The final reports showed overall positive results for many workplace health promotion initiatives (Bull, Adams, & Hooper, 2008; Bull, Adams, Hooper, & Jones, 2008). Physical activity was the main focus of more than half of the initiatives and was perceived as the “easiest to sell to employees”. Findings showed a significant increase in energy expenditure, which was associated with physical activity between baseline and follow-up in six of the projects. A statistically significant increases in active travel was observed in three projects, two of which focused on delivering active travel programmes including links with local initiatives, walking and cycling commuter challenges, bike purchase schemes, bike maintenance and cycling lessons and improved cycle racks/storage (Bull, Adams, Hooper, & Jones, 2008).

As it will be seen later, research showed that not only health promotion programmes can improve the employee’s health conditions, but also they can have positive effects on various business indicators, such as staff morale, productivity, absenteeism, staff turnover and sick days, staff retention and number of injuries (Batt, 2009; Black, 2008; WHO/WEF, 2008). Moreover, increasing the health of employees can also reduce the overall healthcare direct and indirect costs, as it has been discussed before. In fact, “the burden of illness is shared by employers (e.g., through lost productivity) and employees (e.g., through lost work time and sometimes pay); this shared burden provides an impetus for both policy and behaviour change” (USPSTF, 2009, p. 359).

From a public health perspective, workplaces are considered important venues for primary prevention (Dishman, Oldenburg, O’Neal, & Shephard, 1998; Engbers et al., 2005; Hosking, Macmillan, Connor, Bullen, & Ameratunga, 2010; Matson-Koffman et al., 2005). Secondary intervention approaches include occupational health care aimed at facilitating early return to work after illness or disability, for example by improving the quality of life of those affected by back pain (e.g., Bigos et al., 2009; Carroll, Rick, Pilgrim, Cameron, & Hillage, 2010; Schaafsma et al., 2010; Slade & Keating, 2010).

From the point of view of employers, promoting healthy behaviours is also considered a strategic corporate priority (Pelletier, 1991; Pronk & Kottke, 2009). Better work environment, better health outcomes and better business performance are all elements that contribute to the establishment of a healthy workplace, driven by a "culture of health" (Musich, Schubiner, & McDonald, 2009; Pronk & Allen, 2009). A healthy workplace "maximises the integration of employee's goals for well-being and company objectives for profitability and productivity" (Musich et al., 2009, p. 192) and "supports the achievement of a person's best self while generating exceptional business performance" (Pronk & Allen, 2009, p. 224). Moreover, workplace wellness can be implemented with not too many resources to achieve positive return on investment (Lee, Blake, & Lloyd, 2010), as it has been shown also in a recent systematic review by van Dongen and colleagues (2011).

In line with the public health need to address the growing issues of noncommunicable diseases, the importance of workplace health promotion has been growing over the past 30 years, as testified by the large number of organisations constantly offering programmes to their employees. For example, Fielding (1984) reported that the 78% of Californian employers who participated in a 1981 state-wide survey offered one or more health promotion activities, which included, among others, accident prevention, cardiovascular resuscitation, alcohol and drug abuse prevention, mental health counselling, smoking cessation, and exercise programmes (Fielding, 1984). A recent review by Soler and colleagues reported that workplace health promotion programmes were offered by 81% of worksites in 1990 and nearly 90% of all workplaces with at least 50 employees in 2000 (Soler et al., 2010). Additionally, results of the 2004 National Worksite Health Promotion conducted in U.S. and Canada revealed that about 50% of organisations offered a wide variety of programmes to their employees, but this was more likely to happen in organisations with more than 750 employees and comprehensive worksite programmes were offered in the 6.9% of cases (Linnan et al., 2008). Moreover, 70% of organisations considered their health promotion programme an important support to the organization's business strategy and 66.2% reported that it was linked to other key organisational areas (Linnan et al., 2008). Furthermore, the 65% of the worksites interviewed reported having employed at least one person who was in charge for health promotion and worksite wellness (i.e., the so called "organisational health advocate"). The worksites that reported having established health promotion programmes, the 61% said that it has been in place for at least 5 years, 9%, from 6 to 9 years, and 31%, for 10 or more years (Linnan et al., 2008). Some authors noticed that most of the studies and programmes were undertaken in large companies (Fielding, 1984; Linnan et al., 2008; Pelletier, 2005, 2009) or in the public sector and there was a dearth of evidence from small to medium enterprises (SMEs) (Dugdill, Brettle, Hulme, McCluskey, & Long, 2008). This can be considered an element of concern if it is considered that the economic substrate of the European Union consists of SMEs (EU-OSHA, 2003). However, Dugdill et al. underlined that "the sector in general is notoriously difficult to engage in research due to constraints on managers' time and mistrust of health and safety professionals who have predominantly used enforcement as a model of practice" (Dugdill et al., 2008, p. 10).

In the United Kingdom, recent statistics from the Department for Business Innovation & Skills (BIS) show that the SMEs (from 0 to 249 employees) accounted for more than 99% of all enterprises, reaching a total of 4.5 million enterprises (BIS, 2011). In particular, the 99.2% of enterprises were small (from 0 to 49 employees), the .7% were medium-sized (from 50 to 249) and .1% were large (more than 250 employees). In the beginning of 2011, it was estimated that SMEs employed 13.8 million people, which corresponds to the 58.8% of the employment in the whole private sector. The estimated annual turnover was £1,500 billion, which corresponds to the 48.8% of private sector turnover (BIS, 2011). Small enterprises up to 49 employees accounted for the 46% of private sector employment and about 35% of private sector turnover (BIS, 2011).

2.5.1 Workplace health promotion research

Workplace health promotion research covers a broad range of domains and topics as they are associated with interventions aimed at addressing various health risks and their associated behavioural determinants. The increased attention towards workplace health promotion and disease prevention interventions resulted in the production of a substantial evidence-based literature. Workplace health promotion interventions generally targeted individual risk-related behaviours such as substance misuse (i.e., tobacco, alcohol and other substances), sedentary lifestyles, poor nutrition, stress, reproductive risks, and other preventable health behaviours (Quintiliani, Sattelmair, & Sorensen, 2007). Exercise, fitness and smoking cessation were among the most frequently researched areas (Engbers et al., 2005; Heaney & Goetzel, 1997; Lechlitner Lusk, 1997; Quintiliani et al., 2007).

Many studies were reported over the years suggesting that health promotion approaches were effective in changing participants' behaviours and health outcomes, as it was suggested by literature reviews. For example, during the 1990s, evidence suggested promising effects of workplace health promotion initiatives (Gebhardt & Crump, 1990; Marcus, Owen, Forsyth, Cavill, & Fridinger, 1998; Shephard, 1992, 1996; Wilson, 1996; Wilson, Holman, & Hammock, 1996). While some authors reported overall positive results in terms of health outcomes and cost-effectiveness (Harden, Peersman, Oliver, Mauthner, & Oakley, 1999; Lechlitner Lusk, 1997; Pelletier, 1991, 1993, 1996, 1999), others recommended more cautious optimism, based on the fact that methodologically sound, well-designed and appropriately evaluated studies were lacking (Harden et al., 1999; Heaney & Goetzel, 1997; Pelletier, 1993).

In the 2000s, more carefully designed studies produced stronger and suggestive evidence of the effects of workplace health promotion interventions (Hillsdon, Foster, Naidoo, & Crombie, 2004; Marshall, 2004; Pelletier, 2001, 2005, 2009; Quintiliani et al., 2007; Sherman, 2002). More recently, the Task Force on Community Preventive Services produced a summative literature review on the effectiveness of health promotion interventions on employees (Soler et al., 2010). The review focused on interventions that used an Assessment of Health Risks with Feedback (AHRF). The main findings suggested a “strong evidence of effectiveness of AHRF when used with health education with or without other intervention components” (Soler et al., 2010). These findings were consistent with the results of some general reviews about physical activity interventions targeting adults, which found evidence supporting the effectiveness of interventions in broad community settings (Kahn et al., 2002), in the short term and for a middle aged population (Foster et al., 2005) and also in the long term (Müller-Riemenschneider, Reinhold, Nocon, & Willich, 2008).

2.5.2 Effectiveness of worksite physical activity interventions

In this paragraph the effectiveness of workplace health promotion programmes with a focus on physical activity interventions is discussed. The first attempts to systematically review the literature on workplace physical activity interventions date back to the early 1990s. Some literature reviews of that period suggested overall positive effects of interventions on physical activity and health outcomes (Gebhardt & Crump, 1990; Shephard, 1992, 1996), although the strength of the conclusions was characterised as moderate because of the lack of a substantial number of well-designed studies (Shephard, 1996, p. 451). The problem of poorly designed studies or lack in accurate reporting and evaluation was constantly reported in the literature reviews published over the past sixteen years (Dishman et al., 1998; Marshall, 2004; Müller-Riemenschneider et al., 2008; Pelletier, 2009; Proper et al., 2003; Shephard, 1996), which resulted in different conclusions at a review-level.

As it will be shown below, published reviews focusing on physical activity found sometimes contrasting results. The differences in conclusions mostly depend on the fact that reviews were based on different methodologies (i.e., narrative reviews vs. meta-analyses) and inclusion criteria. Nevertheless, the authors noted that the quality of the reported studies increased over time, allowing to produce more accurate reporting and more robust evaluations (Abraham & Graham-Rowe, 2009; Conn, Hafdahl, Cooper, Brown, & Lusk, 2009; Dugdill et al., 2008).

To provide a clear overview about the effectiveness of interventions on physical activity and other health- and work-related outcomes, in the following paragraphs some of the most relevant and noteworthy comprehensive systematic reviews and meta-analyses are presented and summarised. The first paragraph deals with the effects on physical activity and other health-related outcomes, whereas the latter paragraph focuses on work-related outcomes.

2.5.2.1 Effects of interventions on physical activity behaviour

The first seminal meta-analysis that systematically and quantitatively evaluated the evidence was conducted by Dishman and colleagues (1998), who investigated the effectiveness of workplace health promotion programmes on physical activity, physical fitness and health-related outcomes. The review included studies published between 1972 and 1997 carried out among healthy employees and based on randomised controlled trial (RCTs) and controlled trial (CT) designs. Outcome measures included physical activity and physical fitness assessments (i.e., self-reported time spent in physical activity), biological indicators, such as cardiorespiratory fitness, muscle strength and flexibility, body composition), and other health-related outcome measures (i.e., general health, fatigue, cholesterol, blood pressure and musculoskeletal disorders). Of the selected 26 studies, 15 were RCTs and 11 were CTs. The authors found that the average effect size was positive but small ($r = .11$, 95% CI: -.20 to .40), even if the effects varied because of the heterogeneity of measurements and differences in study design. The effects were smaller in experimental than in non-experimental designs and the few studies that used an experimental design yielded small or no effects. Only 10% of the reviewed studies reported large effect size (i.e., larger than .40), suggesting that the programme was successful in changing the outcomes from a control level of 50% before the intervention to 70% after the intervention (Dishman et al., 1998, p. 348). Moreover, very few studies were deemed of high methodological quality. Methodological flaws of the studies included lack of accurate reporting on pre- and post-test measures and procedures involved as well as limitations of the instruments used for collecting data about physical activity (i.e., self-reported or maximum oxygen consumption). Dishman and colleagues concluded that there was no evidence for a positive effect of interventions on physical activity outcomes, partly due to the scientific limitations and to poor research design (Dishman et al., 1998). This conclusion is slightly in contrast with those of Shepard (1996), and the difference in conclusions with Dishman et al.'s review depends on the fact that Shepard did not use meta-analytic techniques to evaluate the effectiveness of the studies.

Another systematic review by Proper et al. (2003) analysed the quality and results of the literature, published between 1980 and 2000, about physical activity promotion in the workplace focusing on physical activity, physical fitness, and health related outcomes. The concept of physical fitness encompassed health-related fitness, including cardiorespiratory fitness, muscle flexibility, muscle strength, and body weight and body composition. Other health outcomes included general health, fatigue, musculoskeletal disorders, blood pressure, and blood serum lipids. The authors conducted a qualitative evaluation of the literature, since a meta-analysis was not possible due to heterogeneity of studies' design and results (Proper et al., 2003). A total of 26 studies was analysed, of these 15 were RCTs and 11 were non-randomised controlled trials. Eight studies (5 RCTs and 3 CTs) evaluating the effect of an intervention on physical activity behaviour were selected. Among these, two methodologically sound RCTs (deemed of "high-quality" according to the rating system developed by the authors) reported that participants in the experimental condition had significantly increased their exercise behaviour and energy expenditure in comparison to the control group (Proper et al., 2003, p. 113). Like in Sherman's (1996) review, the authors concluded that the evidence of effectiveness with regards to physical activity was strong and consistent in that studies showed positive, significant effects in the experimental conditions. Strong evidence was found also for effects on musculoskeletal disorders. However, for the other health-related outcomes, the evidence was judged inconclusive (for cardiorespiratory fitness, muscle flexibility and strength, body weight, body composition, general health), limited (for fatigue), or no evidence (for blood serum lipids and blood pressure outcomes). The conclusions drawn in Proper et al.'s 2003 review were not consistent with Dishman and colleagues' study (1998). The authors recognised that this could be explained by the fact that the reviews differed in terms of methodology (Proper and colleagues used a qualitative appraisal of studies based on a rating scheme).

Marshall (2004) analysed the literature published between 1998 and 2004 and included in the review 32 studies, five of which were RCTs, six randomised trials, seven quasi-experimental trials with a control condition, and the others were non-experimental cohort studies with no control condition (Marshall, 2004). Effect size calculations were computed only from six out of 32 selected studies, because the others did not provide enough information. Marshall found that the average effect size for studies promoting physical activity through motivational prompts was .34; for a workplace exercise programme it was .37; for a study which used individual counselling and for single risk factor intervention programmes it was .40; and for intervention programmes addressing various health risk factors it was .24 (Marshall, 2004, p. 62). The author commented that these effect size estimates were larger than those reported in Dishman and colleagues' review (1998), but were based on a smaller sample of studies (only six), which implied that results should have been interpreted with caution. In line with Dishman et al.'s conclusions, Marshall suggested that the evidence supporting the effectiveness of workplace physical activity interventions was little, and lamented the paucity of few high-quality, methodologically sound studies (Marshall, 2004). Similar conclusions were drawn by Badland and Shofield (2004), who concluded that "little basis exists to demonstrate sustainable increases in health-related physical activity levels when using the workplace as a platform for intervention" (Badland & Schofield, 2004, p. 9).

Different results were found in a 2005 literature review (Matson-Koffman et al., 2005), which focused on policy and environmental interventions promoting physical activity and nutrition. The authors conducted a comprehensive evaluation of the literature published between 1972 and 2003. Twelve studies targeting physical activity in the workplace were included in the review. Of these, two were published before 1990 and 10 after 1990. Overall the authors suggested that the reviewed studies reported overall positive results. One study, published before 1990 (Wilbur & Garner, 1984), reported that participation in a large comprehensive programme - Johnson & Johnson's

Live for Life programme - was associated with a significant increase in energy expenditure (Matson-Koffman et al., 2005) but for a short period of time. Unlike Proper et al. (2003), Matson-Koffman and colleagues reported positive results of in reducing participants' cholesterol level and systolic blood pressure. Consistent with Proper et al.'s and Shepard's reviews, Matson-Koffman et al. concluded that policy and environmental interventions could increase levels of physical activity even though for a short term (Matson-Koffman et al., 2005). These conclusions contrasted with those presented in another contemporaneous systematic review, which focused on environmental changes in the workplace on physical activity, and concluded that the evidence was inconclusive (Engbers et al., 2005).

Another noteworthy systematic review of the literature about workplace physical activity interventions effectiveness was conducted by Dugdill et al. (2008). The authors included 38 papers, published between 1996 and 2007, representing 33 interventions including seven specifically aimed at influencing stair walking, four aimed at increasing walking to and from the workplace and the rest were multi-component studies.

With regards to stair walking, the results of the studies were judged inconsistent as both positive and negative effects were reported. Authors concluded that there was limited evidence of the effectiveness of interventions influencing stair walking (Dugdill et al., 2008), when these interventions used ineffective means of promotion. This result was in line with those reported in another previous narrative review, which focused on interventions aimed at increasing stair climbing in the workplace (Eves & Webb, 2006). This was confirmed also by a contemporaneous study conducted in an NHS setting in the U.K. (Blake, Lee, Stanton, & Gorely, 2008). Authors reported no statistically significant differences in stair climbing or descent through the introduction and removal of promotional posters (Blake et al., 2008).

Interventions aimed at increasing walking to and from workplace showed overall positive and significant results, suggesting that they contributed to a significant behaviour change (Dugdill et al., 2008). Multi-component interventions included a combination of counselling, motivational interviewing, health checks, screening, health promotion messages, information, led activity sessions, and active travel. The reviewers found that workplace counselling was effective in changing behaviour, whereas the evidence for health promotion messages and information was inconclusive (Dugdill et al., 2008). Overall, Dugdill and colleagues concluded that the workplace physical activity interventions showed good potential in influencing physical activity behaviour.

More recently, two meta-analyses on the effectiveness of workplace health promotion interventions on physical activity were conducted (Abraham & Graham-Rowe, 2009; Conn et al., 2009) showing comparable results and producing a methodologically sound and quantitatively supported evaluation of the evidence, which has not yet been updated. Abraham and Graham-Rowe (2009), with the aim to update Dishman et al.'s (1998) study, investigated the literature published between 1997 and 2007. The authors included in the review 37 evaluations reporting the results of about 55 interventions; 10 of these were present also in Dishman et al.'s review. The authors were able to calculate 57 effect sizes from 37 evaluations selected (because different papers provided more than one outcome measure).

Overall Abraham and Graham-Rowe discovered that worksite interventions had a small positive effect on physical activity level (d = .20), with considerable heterogeneity between the studies. However, the estimates varied little between studies conducted before (d = .17) and after 1997 (d = .22). They also found that fitness outcome measures were smaller in effect than self-reported physical activities (.13 versus .23). Abraham and Graham-Rowe concluded that worksite interventions targeting physical activity (and specifically walking or step counting) were more effective than those targeting general lifestyle changes, but when fitness outcomes were considered, the evidence of effectiveness was weaker. However, the authors suggested that if the effects, albeit small, were replicated across the population (and maintained) "the average increase in population fitness is likely to have considerable health and economic impacts" (Abraham & Graham-Rowe, 2009, p. 140).

Similar findings were reported in the other meta-analysis by Conn and colleagues (2009) who offered a more extensive review of studies, by including papers published from 1969 through 2007 (Conn et al., 2009). The authors evaluated results from 138 studies and reports finding overall significant effects on physical activity, fitness, lipids and anthropometric measures (i.e., BMI) and also for psychological indicators, such as mood and perceived quality of life. For physical activity, the average effect size was .21 (similar to Dishman et al.'s and Abraham & Graham-Rowe's reviews), for fitness it was .57, for lipids .13, for other anthropometric measures it was .08, and for mood and quality of life were .13 and .23 respectively. According to Conn et al., these findings supported the argument that some interventions might improve physical activity, but due to the highly significant heterogeneity of the estimated effects, results had to be interpreted with caution (Conn et al., 2009).

The estimates of effect sizes for physical activity in both Abraham and Graham-Rowe's (2009) and Conn et al.'s (2009) reviews were in line with those estimated in Dishman et al.'s review (1998) and were consistent with those previously reported in other systematic reviews about community-based and general physical activity interventions in community settings, which were associated with small effects (Baker et al., 2011; Foster et al., 2005; Hillsdon et al., 2004; Hillsdon & Thorogood, 1996).

More recently, three other systematic reviews investigated some specific aspects of physical activity in the workplace, finding similar results compared to the previously reported meta-analyses. For example, one systematic review focused on interventions to reduce sitting (Chau et al., 2010). The lack of sufficient information for conducting a meta-analysis (only six studies met the inclusion criteria) and the fact that the reduction of time spent sitting was a secondary objective, the authors concluded that there is insufficient evidence to conclude that interventions aimed at reducing time spent sitting were effective (Chau et al., 2010). Another systematic review dealt with the integration of short bouts of physical activity into organisational routine (Barr-Anderson, AuYoung, Whitt-Glover, Glenn, & Yancey, 2011). The authors reviewed 11 unique worksite interventions, which showed significant but modest improvements in physical activity. However, the results on other outcomes (e.g., work performance) were judged inconsistent suggesting that the effect of short exercise bouts on work performance outcomes was mixed (Barr-Anderson et al., 2011).

Another systematic review and meta-analysis investigated the effectiveness of physical activity and nutritional programmes in the workplace (Hutchinson & Wilson, 2011). The authors analysed the literature published between 1999 and 2009 and reviewed a total of 29 studies, grouped according to different theoretical frameworks theoretical framework on which the interventions were based (i.e., health education, cognitive-behavioural, motivation enhancement, social influence, exercise). The authors found that theoretical approaches reported overall small effects. Larger effects were found in interventions that used motivation enhancement and in studies that focused on one health behaviour and in RCTs (Hutchinson & Wilson, 2011).

The effectiveness of workplace physical activity interventions on other health-related outcomes (such as body fat and BMI) showed moderate results, as well. For example, two recent meta-analyses investigated the effects of workplace physical activity and nutrition interventions on body weight, BMI and other related measures finding similar results (Anderson et al., 2009; Verweij, Coffeng, van Mechelen, & Proper, 2011). In Anderson and colleagues' review (2009), which analysed the literature published between 1966 and 2005, the pooled results extracted from six RCTs showed that employees decreased of 2.8 pounds in weight (95% CI: 4.60 to 1.00) and .50 in BMI (95% CI: .80 to .20) when compared to controls at 6 to 12-months follow-up (Anderson et al., 2009). The authors concluded that there is "strong evidence of a consistent, albeit modest, effect" (Anderson et al., 2009, p. 355). Verveij et al. analysed the literature published between 1980 and 2009 and focused only on studies based on RCT design. They evaluated the following outcomes: body weight, BMI, and body fat percentage (calculated from a sum of skin-folds). In total twenty-two studies were selected and analyses were conducted separately for each outcome. For interventions targeting physical activity and dietary behaviours, the pooled results from nine studies showed that the mean difference in body weight in nine studies was -1.19 kg (95% CI: -1.64 to .74), in BMI in six studies it was -.34 kg/m^2 (95% CI: -.46 to -.22), and body fat percentage was -1.12% (95% CI: -1.86 to -.38). However, for interventions focusing only on physical activity, there quality of evidence was judged low and inconsistent for all outcomes measured (body weight, BMI and body fat percentage). Consistent with Anderson et al.'s review, Verveij and colleagues concluded that there was moderate evidence suggesting that workplace interventions promoting both physical activity and dietary behaviour can significantly reduce body weight, BMI and body fat percentage (Verweij et al., 2011).

Another recent systematic review analysed workplace physical activity studies carried out in Europe and published up to December 2009. The authors found moderate evidence of effectiveness for physical fitness outcomes with exercise training interventions and for physical activity outcomes with active commuting interventions, but these interventions were considered promising approaches to promote physical activity in the workplace (Vuillemin et al., 2011).

2.5.2.2 Effects of interventions on work-related outcomes

In general, various studies investigated the relationship between participation in workplace health promotion and work-related outcomes, including absenteeism and productivity (Kirsten, 2010; Koffman et al., 2005; Riedel, Lynch, Baase, Hymel, & Peterson, 2001; Soler et al., 2010; Stein, Shakour, & Zuidema, 2000) and, more recently, on presenteeism (Block et al., 2008; Brown, Gilson, Burton, & Brown, 2011; Cancelliere, Cassidy, Ammendolia, & Côté, 2011; Chapman, 2005a; Kirsten, 2010; Schultz & Edington, 2007). Presenteeism is an emerging topic in workplace health, which encompasses the idea of reduced ability to work productively (Hemp, 2004). It means "being at work 'on the job', but performing below par, because of illness or medical conditions (Cooper & Dewe, 2008, p. 523).

As for behaviour, the effects of worksite physical activity interventions on work-related outcomes showed moderate and mixed results at a review-level, suggesting cautious interpretations, especially because the evidence is limited on very few studies. For example, Aldana (2001) systematically reviewed the literature to assess whether participation in health promotion programmes and fitness programmes was associated with improved financial outcomes, which were defined as reduction in absenteeism and in employee-related health care expenditures. Regarding the association between participation in fitness programmes on absenteeism and health care costs, the participation tended to be associated with significant decreased levels of short-term (1 year) absenteeism and decreased health care costs. Aldana found that the average savings for absenteeism were $5.82 per dollar invested in the programme (Aldana, 2001).

Regarding the impact of physical activity on health care costs, Aldana found that on average, the savings from health care were $3.48 per dollar invested in the programme. Despite the low quality and paucity of studies analysed, the author suggested that participation in a fitness programme had moderate positive effects on absenteeism and health care costs (Aldana, 2001). These results were in line with another contemporaneous general literature review on workplace health promotion and productivity (Riedel et al., 2001). The authors concluded that “the effect of exercise on performance shows short-term reductions in absenteeism and reduced turnover” (Riedel et al., 2001, pp. 176–177).

Proper et al. (2002) reviewed the literature focusing on interventions targeting physical activity, using the same methodology as in the previously discussed systematic review on health-related outcomes (Proper et al., 2003). The 2002 review included studies that reported work-related outcomes such as absenteeism, work productivity, employee turnover, job satisfaction and job stress. Eight studies (four RCTs and four CTs) met the inclusion criteria and were analysed. As in Aldana’s review, due to the lack of good quality studies, the authors could not draw strong conclusions on the effectiveness of the interventions on work-related outcomes. The majority of interventions (five out of eight) evaluated the effect on sick leave and three of them did not show significant effects. One of the studies (Kerr & Vos, 1993), found a significant effect of a fitness programme on decreased absenteeism among participants. However, given the small amount of studies, Proper et al. concluded that the evidence for a positive effect on absenteeism was limited, while for the other outcome measures the evidence was deemed inconclusive (Proper, Staal, Hildebrandt, van der Beek, & van Mechelen, 2002).

In a systematic review, Chapman (2005b) reviewed the literature published between 1982 and 2005. Using a larger sample of 56 studies (as opposed to Aldana’s and Proper et al.’s), Chapman found that on average, on a timeframe of 3.6 years, worksite programmes were found to achieve from 25% to 30% reduction in health care costs and absenteeism-related costs (Chapman, 2005b). In particular, participation in workplace health promotion programmes was associated with an average 27% reduction in sick leave absenteeism, 26% reduction in health care costs, 32% reduction in employee's compensation and disability costs, and savings of $5.8 for every dollar invested in the programme (Chapman, 2005b).

A meta-analysis by Kuoppala et al. (2008), who reviewed the literature published between 1970 and 2005, found overall moderate evidence that exercise can increase work ability (RR[5] = 1.38; range = 1.15 – 1.66). No significant improvements were found for education and psychological methods on sickness absence (Kuoppala, Lamminpää, & Husman, 2008). Positive and moderate evidence of effectiveness on work-outcomes was found in the previously reported review by Conn et al. (2009), which evaluated employees' work attendance (as indicator of absenteeism), job stress, job satisfaction, and health care utilisation. The authors found that, on average, participants in the intervention groups had lower mean absenteeism than those in the control groups, and this was associated with a moderate effect size of .19 (CLES[6] = .55). Job stress was also significantly lower at follow-up among intervention than among control participants (effect size = .33, CLES = .59). Job satisfaction was found to be significantly greater among intervention groups (effect size = .20, CLES = .54). Healthcare utilization was significantly higher among intervention participants than among control participants (effect size = .17, CLES = .45). The authors concluded that these findings offer a tentative suggestion that workplace physical activity can produce positive results in terms of work-outcomes, but the small effects sizes allow for cautionary interpretations (Conn et al., 2009, p. 334).

Two systematic reviews (Brown et al., 2011; Schultz & Edington, 2007) dealt with the problem of presenteeism. Schultz and Edignton (2007) conducted a general

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[5] RR indicates risk ratio, which is "a measure of the risk of a certain event happening in one group compared to the risk of the same event happening in another group" (NCI, National Cancer Institute, n.d.).
[6] CLES stands for "Common Language Effect Size" (McGraw & Wong, 1992), based on a random-effects mean effect size for two-group post-test comparisons. For example a CLES of .56 indicates that a random treatment participant would have 56% of the time a higher physical activity score than a random control participant (Conn et al., 2009, p. 332).

systematic appraisal of interventions associating on-the-job productivity with various health risks factors and health conditions (e.g., obesity, physical activity, various chronic conditions, etc.). Since only two studies focused on the relationship between physical activity and presenteeism, and since the quality of these studies was judged as relatively low, they concluded that it was not possible to consistently evaluate their effectiveness (Schultz & Edington, 2007). A more recent review with qualitative synthesis by Brown and colleagues (2011) the authors found a weak and limited evidence of a relationship with presenteeism (Brown et al., 2011).

In summary, based on the reported reviews and studies, the quality of the reported data was poor and many reviews lamented the lack of well-designed randomised controlled trials that could carefully isolate the effects of an intervention (Abraham & Graham-Rowe, 2009; Dishman et al., 1998; Dugdill et al., 2008; Engbers et al., 2005; Proper et al., 2003). These results are in line with the research trends highlighted in Pelletier's 2009 review: there were fewer clinical trials and increase in demonstration non-experimental and pre-experimental projects conducted by companies (Pelletier, 2009). The same trend was noted in the previous reviews of 2001 (Pelletier, 2001) and 2004 (Pelletier, 2005). Quantitative analyses of the effects of interventions on physical activity showed moderate support to their effectiveness on behaviour and on work-related outcomes. Reviewers suggested that more studies with appropriate designs could provide improved results in the future (Conn et al., 2009).

2.5.3 Participation in workplace health promotion programmes

The success of workplace health promotion programmes has been questioned, since it has been noted that participation rates are often low and a relatively small proportion of employees take part to these interventions (Lewis, Huebner, & Yarborough, 1996; Robroek, van Lenthe, van Empelen, & Burdorf, 2009). For example, Dishman and colleagues reported estimates indicating that participation rates in workplace health promotion programmes in North America ranged from 20% to 30% (Dishman et al., 1998). Another indicator of participation is the retention rate, which measures the amount of people that is retained in a programme. Some reviews reported that retention rates ranged from 51% to 63%, with some studies showing retention rates as high as 80% (Marshall, 2004). In a more recent review, Robroek and colleagues reported that overall participation rates in general health promotion programmes ranged from 10% to 40% (Robroek et al., 2009). Low participation rates are reported also in technology-based worksite physical activity interventions are also reported in studies (e.g., Cook, Billings, Hersch, Back, & Hendrickson, 2007; Spittaels & De Bourdeaudhuij, 2007; Spittaels, De Bourdeaudhuij, Brug, & Vandelanotte, 2007) and in the review literature (Neville, O'Hara, & Milat, 2009). For example, in a study by Franklin and colleagues (Franklin, Ploutz-Snyder, et al., 2006), who used e-mail to promote health in the workplace, the researchers were able to recruit about 24% of eligible workers across 19 worksites. Another study by McHugh and Suggs (2011), conducted in an applied setting, with a large, diverse, and geographically dispersed workforce, and involving a tailored health risk assessment reported a 9% participation rate (McHugh & Suggs, 2011).

There have been reported differences in participation rates in programmes as function of the type of service offered. Some studies reported that workplace fitness programmes received more attention and reached higher participation rates than general health promotion programmes (Gebhardt & Crump, 1990; Joslin, Lowe, & Peterson, 2006; Pelletier, 2009; Shephard, 1996). Within workplace wellness and fitness programmes, a study identified two factors that best describe the type of interventions preferred by employees: medical offerings and health education offerings. Medical offerings were found to attract more employees, resulting in higher participation rates compared to wellness programmes involving health education and health counselling, which required more time to complete, and more direct and active individual involvement (Joslin et al., 2006). A limitation for these studies it that they require a large financial investment and long-term commitment of the organisation, so that workplace health promotion campaigns or short-term interventions are often preferred by employers (Fielding, 1984; Marshall, 2004; Robroek et al., 2009).

The role of managerial and employer support in promoting health promotion programmes and increasing participation rates was supported by some literature (DeJoy et al., 2009; Heinen & Darling, 2009). Employers seem to understand that increasing or maintaining high participation rates is a key asset, because low participation levels will result in decreased cost effectiveness and in potentially decreased generalizability of the results (Robroek et al., 2009).

An essential condition for the success of a workplace health promotion intervention is "the interest and willingness of employers to support such programmes and of employees to participate" (Harden et al., 1999, p. 545). Some studies investigated the individual-level determinants of participation in physical activity among employees. Robroek et al. found also that gender was positively associated with participation in health promotion programmes: generally, female workers tended to participate in health educational and multi-component programmes more frequently than men (OR = 1.67; 95% CI: 1.25 to 2.27), but this difference was not observed for interventions consisting of access to fitness centre programmes. Higher participation levels were found also in people living as couples (married/cohabiting) compared to other family statuses (OR = 1.25, 95% CI: 1.05 to 1.48). Age, education, ethnicity and income were identified as potential correlates of participation in workplace health promotion programmes, but the direction and the magnitude of the relationships with participation were mixed and associations with participation were non-significant. Regarding work-related characteristics, some studies reported significant positive associations between full-time work status and with the condition of having a secure contract, whereas negative associations were found with shift working. Furthermore, higher participation was found in programmes offering incentives, but no difference in participation levels was found between programmes requiring a fee and programmes with free participation (Robroek et al., 2009). Kaewthummanukul and Brown showed that also various cognitive and psycho-social factors (i.e., perceived self-efficacy, attitudes, social norms and intention, motivation readiness, etc.) play a crucial role in increasing participation rates in workplace health promotion programmes (Kaewthummanukul & Brown, 2006).

Nevertheless, very little is known about the reasons and motivations that drive employees into enrolling in such programmes, and not enough effort is made to understand how these interventions could reach a broader audience (Chapman, 2006;

Glasgow, McCaul, & Fisher, 1993; Robroek et al., 2009). Some researchers investigated the reasons for non-participation in physical activity interventions in a primary care setting (Chinn et al., 2006) and among students (Abdullah et al., 2005), but to date no studies investigated both the reasons for participation and non-participation in a physical activity promotion intervention targeting employees.

2.5.4 Elements of success

Even though the evidence on workplace physical activity interventions is not yet considered unanimously strong at least at a review level, it is possible to identify certain characteristics of the interventions that could be associated with positive outcomes and effective results. Based on the findings of the literature reviews previously presented and on results of some recent studies, in the following paragraphs relevant elements of success are discussed.

2.5.4.1 Theory-based and behaviour-focused interventions

Along with long-term commitment of the employer and with the implementation of comprehensive approaches in workplace health promotion, to successfully achieve behaviour change, information and behavioural strategies are recommended (USPSTF, 2009). In fact, "theory and research suggests that the most effective health behaviour change interventions are those that use multiple strategies and aim to achieve multiple goals of awareness, information transmission, skill development and supportive environments and policies" (Glanz, 2009, p. 195). Also Marshall (2004) asserted that workplace health promotion interventions that incorporate contemporary behaviour change theories "along with organisational change issues (such as issues relating to workplace culture and the need for adjustments at an organisational level) may be more successful" (Marshall, 2004, p. 63).

The importance of using theory in health behaviour change interventions and health promotion has been advocated by many authors (e.g., Glanz & Bishop, 2010; Glanz, Rimer, & Viswanath, 2008a; Nutbeam, 1999; Painter, Borba, Hynes, Mays, & Glanz, 2008). In addition to that, one indicator of the increased attention towards theory is the "inclusion of description and coding of the theoretical bases of interventions in authoritative systematic reviews such as those conducted by the Task Force on Community Preventive Services" (Glanz & Bishop, 2010, p. 404).

According to McEachan and colleagues, theory is important for three main reasons: first, because theories offer suggestions about what theoretical constructs could best explain or predict behaviour and these could provide a focus to the intervention. Second, because theories can provide guidance as to which methods are more efficacious in changing these constructs and how to use them for behaviour change. Third, theory is important to explain the reasons for change (McEachan, Lawton, Jackson, Conner, & Lunt, 2008). For Glanz and Bishop, theory is useful because it assists researchers in the identification of beliefs and barriers to specific behaviours and other relevant information needed to design effective interventions and may provide insight into how to design a program so that it is more successful (Glanz & Bishop, 2010).

What are the most frequently used theories in health behaviour?

According to the review of articles published between 1999 and 2000, and reported in the book *Health Behavior and Health Education: Theory, Research, and Practice* (Glanz, Rimer, & Viswanath, 2008b), the most frequently used theories in health behaviour research in the last ten years were the following: the Social Cognitive Theory, developed by Bandura (1986), the Transtheoretical Model/Stages of Change, developed by Prochaska and DiClemente (1992). Other relevant and frequently used theories and models were the Health Belief Model (HBM) developed in the 1950s, social support and social networks, the Theory of Reasoned Action/Theory of Planned Behaviour (Ajzen, 1985, 1991; Ajzen & Fishbein, 2010), stress and coping, community organization, ecological models/social ecology, and diffusion of innovations (Glanz et al., 2008a). More recently, the same authors, while reviewing other reviews about health behaviour research, showed that the most often used theories were SCT, TTM/stages of change, HBM, TPB, and PRECEDE/PROCEED planning model (Glanz & Bishop, 2010).

Similar results were found in a Painter and colleagues' systematic review of articles on health behaviour interventions published between 2000 and 2005: the most frequently utilised theories in studies that mentioned theory (n = 69) were the Transtheoretical Model/Stages of Change (27.5%), the Social Cognitive Theory (27.5%), the Health Belief Model (20.0%), the Theory of Reasoned Action/Theory of Planned Behaviour (15.9%), and the Social Networks/Social Support theory (15.9%). The authors noted that the use of these 'traditional' theories remained constant in the health behaviour research literature over the last twenty years (Painter et al., 2008).

In the exercise domain, some years ago, Biddle and Nigg (2000) found that the most supported theories were the Theory of Planned Behaviour, the Self-efficacy theory and the Transtheoretical Model (Biddle & Nigg, 2000). More recently, Bélanger-Gravel et al. (2011) reported that the theoretical frameworks most often applied in physical activity intervention research are the traditional Behavioural Model used in clinical psychology (i.e., behaviour therapy) and the Social Learning/Social Cognitive Theory. Other theories were the Transtheoretical Model, the Relapse Prevention Model, the Self-Control Theory, the Elaboration Likelihood Model, the Decision Theory, the Health Belief Model, the Decisional Balance, and the Theory of Planned Behaviour. Interestingly, the authors noted, relatively little attention has been paid to the literature on the determinants of physical activity and the important contribution of theories such as the Theory of Planned Behaviour, which has shown good predictive validity in the physical activity domain (Bélanger-Gravel, Godin, Vézina-Im, Amireault, & Poirier, 2011).

Are theory-based interventions more effective than non-theory-based interventions?

Some authors claimed that there is evidence that psychological interventions based on theory are effective in changing health behaviours. For example, Hardeman et al. (2002), who systematically examined the literature about behaviour change interventions using the Theory of Planned Behaviour (see paragraph 2.7), found that in about half of the interventions evaluated, a change in intention was reported, but it was associated with generally small effect sizes (Hardeman et al., 2002). Also Michie and Abraham (2004) argued that theory-based interventions were more effective than other non-theory-based interventions in describing and changing healthy behaviours such as condom use, smoking, exercise, and diet (Michie & Abraham, 2004). The same view was shared by Glanz and Bishop (2010), in summarising their systematic review of articles published from 2000 to 2009: "several reviews concluded that interventions based on theory or explicitly described theoretical constructs were more effective than those not using theory […] however the mechanisms that explain these larger effects have not been studied" (Glanz & Bishop, 2010, p. 404).

In the previously cited work by Bélanger-Gravel and colleagues, the authors examined whether long-term effects on physical activity participation were achieved in theory-based interventions targeting overweight and obese individuals (Bélanger-Gravel et al., 2011). Surprisingly, the authors found little evidence about the effectiveness of theory-based interventions, being the lack of methodology and appropriate testing the major limitations of current research studies (Bélanger-Gravel et al., 2011).

Similar limitations in the appropriate application of behaviour change theories in the development and evaluation of interventions was highlighted also in Michie and Abraham's and Painter et al.'s reviews (Michie & Abraham, 2004; Painter et al., 2008). Michie and Abraham stated that it was difficult to "identify particular techniques that are critical to intervention effectiveness because these are confounded with each other and with other intervention characteristics, including form of delivery, intensity, and duration" (Michie & Abraham, 2004, p. 46). Painter et al.'s (2008) distinguished between interventions that were informed by theory, applied theory, tested theory, and built or created new theory. Informed by theory were those studies that identified a theoretical framework, but did not explicitly describe theoretical components and measures related to a theory. Applied theory interventions were defined as those using a specific theoretical framework and including measures for specific constructs within a study. Interventions that tested theory were defined as adopting a specific theoretical framework and measured and tested more than half of the specified theoretical constructs, or when two or more theories were compared with each other in a study. Building/creating theory studies were those studies that created new theories or revised or expanded existing theory by using constructs specified, measured, and analysed in a study (Painter et al., 2008). The authors found that the majority of studies were 'informed by theories'. In fact, of all the theories used in the sample of articles, 69.1% used theory to inform a study, 17.9% applied theories, 3.6% tested theories, and only 9.4% involved generation of new theories (Painter et al., 2008). These reviews called for more experimental testing of specific theory-based techniques, separately and in combination and the reporting of appropriately design studies that isolated theoretical components (Michie & Abraham, 2004; Painter et al., 2008).

In the specific field of workplace physical activity interventions, a more recent meta-analysis and meta-regression by Taylor, Conner and Lawton (2012) discovered that, among 26 reviewed interventions, published between 1975 and 2009, those based on theories were more effective than those that did not use theory, achieving small to moderate effects: $d = .34$ (95% CI: .23 – .45). However, despite overall positive findings supported by more appropriate and good quality designs, the authors underlined that the quality of the evidence needed to improve in order to understand what works best in theory-based interventions (Taylor, Conner, & Lawton, 2012).

2.5.4.2 Motivational prompts and new technologies

Workplace health promotion interventions promoting physical activity through motivational messages and prompts have been advocated in various systematic reviews (e.g., Marshall, 2004; Harden et al., 1999). Some studies found evidence of effects of motivational prompts (e.g., e-mail reminders) in the workplace (Abraham & Graham-Rowe, 2009; Dugdill et al., 2008; Marshall, 2004; Matson-Koffman et al., 2005; Robroek et al., 2009). Some authors recommended the use of theory-based, individually tailored messages through e-mail, Internet, or personal data assistant devices because they could "allow for easier integration with other workplace tasks" (Marcus et al., 2006, p. 2743).

In the 2009 ACSM's worksite health handbook, Ahern and colleagues stated that: "e-mail in the workplace has become ubiquitous and is used as major channel of communication. Furthermore, it has the potential to serve as a platform for providing health information and tailored health messages to employees as part of an overall health improvement programme" (Ahern, Buckel, Aberger, & Follick, 2009, p. 251). Moreover, according to Pelletier (2009), one of the emerging trends is the use of new information and communication technologies: "Computers, e-mails, cell phones and other evolving wireless devices will create a convenience of access and use that is known to be a major determinant of sustained healthy behaviour" (Pelletier, 2009, p. 834).

The effectiveness and special features of new information and communication technologies will be reviewed in the following paragraph.

2.6 Information and communication technologies for health promotion

2.6.1 What is e-health?

In the last twelve years, the steady growth of information and communication technologies has opened up avenues for innovative mass-reach interventions in health promotion. Automated message systems, mobile phones, e-mail and Internet are now commonly used for education, motivation, incentive, and continued support for improving health outcomes in a range of health areas at relatively low costs. In this context, e-health (or eHealth) has rapidly emerged as a specialised field of research in the health domain, combining the application of information and communication technologies (ICT), medical informatics, telemedicine, public health, health communication, and business (Neuhauser & Kreps, 2003). Even if more than 50 unique definitions for e-health have been identified (Oh, Rizo, Enkin, & Jadad, 2005), there is a tacit understanding about its scope, which can be summarised through Eysenbach's (2001) words: e-health refers to "health services and information delivered or enhanced through the Internet and related technologies" and in a broader sense, it is also a "state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology" (Eysenbach, 2001, p. 1).

According to Neuhauser and Kreps (2010), examples of e-health applications include web-based health information, computer-assisted learning, online support groups and collaborative communities, computer-tailored information, interactive television, computer-controlled in-home telephone counselling, biometric assessment and monitoring, and patient provider e-mail contact (Neuhauser & Kreps, 2010). Neuhauser and Kreps (2010) emphasised that e-health communication offers great promise in enhancing the theoretical foundations of health behaviour models as it allows creating more personalised communication, and enhancing its interactivity. Health communication through new technologies can foster "user-centred design and interactivity, broad social connectivity, deeper understanding of what motivates behaviour change beyond 'risk', and the use of multimodal media that expand people's access to health information and discourse across time, place, and cultures" (Neuhauser & Kreps, 2010, p. 15).

E-health does not include only computer-based technologies. In the last fifteen years, the use of mobile technologies has grown around the world, and mobile technology is increasingly used to promote health as well as prevent diseases (e.g., Fjeldsoe et al., 2009; Istepanian & Pattichis, 2006). From this perspective, the term "m-health" (or mHealth), which stands for "the use of mobile phone technology to deliver health care" (Cole-Lewis & Kershaw, 2010, p. 57), became used often as a specific branch of e-health. Even though there are differences in type of media and technology involved, it is out of the scope of this dissertation to provide a discussion. In this dissertation, e-health will be used in its broader sense, and it will include computer-based, internet-based and non-computer-based technologies (i.e., mobile phones).

General e-health research covered various aspects of technology use, telemedicine, healthcare service delivery, but in general put emphasis on the communicative functions of e-health and specifically on the use of the Internet (Pagliari et al., 2005). The potential of the Internet as important medium for health communication and health information has been already addressed and supported in various reviews (e.g., Bennett & Glasgow, 2009; Kreps & Neuhauser, 2010; Schiavo, 2008). However the scope of e-health research has expanded to other forms and other technologies. For instance, computer-based communication and mobile technologies can serve as persuasive tools for health behaviour change (e.g., Fogg, 2002; Lehto, 2012). In fact, they can be used to assist behaviour change through their characteristics of customisation, personalisation, self-monitoring and reinforcing the desired behaviour, and prompting behaviour with 'nudges' (Thaler & Sunstein, 2009).

In a scoping review about research in information technologies in health promotion, Lintonen, Konu and Seedhouse (2008) identified four major thematic areas of research, through a qualitative analysis of the content and orientation of 56 articles published between 2003 and 2005. A proposed taxonomy for ICTs in health promotion included, information technology as 1) research focus, 2) a research instrument, 3) 'intervention medium' for disseminating the content of a programme, and 4) for professional development (Lintonen, Konu, & Seedhouse, 2008). The most frequently reported role for information technologies was 'intervention medium', which means that e-mails, mobile phones and computers were mainly used to distribute health information; however the aim of influencing behaviour change was clear. Another commonly reported role of information technology was 'computer tailoring', which is the use of computers to create messages based on users' characteristics (Lintonen et al., 2008).

Mobile phones and m-health

Along with web-based and computer-based technologies, mobile phones are becoming more commonplace in health communication in general. Mobile technologies include among various features, text messaging (SMS), video messaging, voice calling, and Internet connectivity (Cole-Lewis & Kershaw, 2010), and allow to send and receive information or communication across distances to and from other devices (Lefebvre, 2009). In line with Lintonen et al.'s (2008) taxonomy, mobile phones and handheld devices are becoming used as 'intervention medium' in public health interventions.

Text messaging is the most widely adopted and least expensive technological feature of mHealth (Cole-Lewis & Kershaw, 2010). Text messaging was used applied in youth smoking cessation programmes (e.g., Whittaker et al., 2008), or youth alcohol consumption (Suggs et al., 2011). Mobile phones are often used in patient care (e.g., Blake, 2008a) and in chronic disease management (e.g., Blake, 2008b; Cole-Lewis & Kershaw, 2010) for weight loss in various settings and among different populations (e.g., Fukuoka, Vittinghoff, Jong, & Haskell, 2010; Patrick et al., 2009; van Wier et al., 2011; Ware et al., 2008), or for general behavioural change interventions (Fjeldsoe et al., 2009) and for physical activity interventions (e.g., Hurling et al., 2007; Patrick et al., 2009; Prestwich, Perugini, & Hurling, 2010; Shapiro et al., 2008). Mobile phones could be also used as 'research instrument' for data collection. For instance, some studies showed that they can be used for physical activity measurement (e.g., Bexelius et al., 2010; Bexelius, Sandin, Trolle Lagerros, Litton, & Löf, 2011). Another example of an application that allows to measure behaviour (and physical activity in particular), is Heart Angel, a software for mobile phones, which includes cardio-respiratory tests, heart rate monitor integration and a location tracking application for analysing heart rate exertion over time and location, and a game called Health Defender (Garcia Wylie & Coulton, 2009).

E-health and workplace health promotion

E-health has started to be applied also in workplace health promotion, where various interventions "included the use of technology (e.g., Internet, e-mail) to encourage positive health behaviours among employees, such as healthy eating, physical activity and smoking cessation" (Blake & Lloyd, 2008, p. 4). Pelletier in his 2009 review update on studies of comprehensive health promotion and disease management prevention programmes suggested that computers and e-mails, cell phones as other devices "will create a convenience of access and use that is known to be a major determinant of sustained healthy behaviour. Such a model might be more cost effective than our current infrastructure. […] Although this is yet to be determined, it has the potential for disseminating relevant, timely, and targeted health information" (Pelletier, 2009, p. 834).

E-mails, as they are often used by employees, support the idea of effectiveness, because they could reach a large number and wide variety of employees in the workplace, and encourage active participation. However, possible limitations of using these technologies include the fact that e-mails are not regularly opened and that people receive a large amount of e-mails, which translates into an information overload. Thus, these factors might limit the effectiveness of tailoring health information and content through e-mails (Marshall, 2004; Thompson et al., 2006).

As previously seen in Dugdill et al.'s (2008) review, motivational prompts were used in two studies that used written e-mail or doctor's e-mail communication to encourage physical activity in the workplace (Marshall, Leslie, Bauman, Marcus, & Owen, 2003; Plotnikoff et al., 2005). Another example of an e-health platform tool used in a sedentary lifestyle is a study by Franklin and colleagues (2006), which was undertaken in a health insurance company in New York. The intervention targeted nutrition behaviour and the core topics were fruit and vegetable consumption. Results showed that 81% of employees opened e-mails daily for 23 weeks or longer and more than 50% continued to open the programme e-mails for 23 weeks (Franklin, Ploutz-Snyder, et al., 2006; Franklin, Rosenbaum, Carey, & Roizen, 2006).

Internet, e-mail and mobile phone access in the United Kingdom

According to the Office of National Statistics, in the United Kingdom, in 2011 the 77% of households had internet access, most of which was provided by broadband (93%). The 95% of households accessed the Internet from home, whereas the 43% from work. The 86% of respondents reported using the Internet to send and receive e-mails. For working age adults (18-65 years) this proportion reached the 87% (ONS, 2011a).

The proportion of employees who had Internet access in the work place increased slightly from 47.6% in 2009 to 48.2% in 2010. In 2010, 95.1% of businesses had Internet access, with 92.3% connected using broadband (ONS, 2011b).

There were 17.6 million mobile phone Internet users in 2011, representing 45% of Internet users, compared to 8.5 million users (23%) in 2009. Of these, 6 million accessed the Internet over their mobile phone for the first time in 2011. The proportion of mobile phone ownership in the U.K. increased over the past 10 years: from 58% in the 2000, when the General Household Survey first asked about mobile phones, to the 85% in 2010 (ONS, 2012). For mobile internet in the workplace, there was a significant increase in the use of mobile broadband in 2010. Over half of businesses (51.9%) used mobile broadband using 3G, compared with 36.0 per cent in 2009 (ONS, 2011b). These data provide an estimate of the penetration of these media in the population of employees in the United Kingdom.

2.6.2 Effectiveness of e-health interventions for physical activity

As in workplace health promotion interventions targeting physical activity, the evidence of e-health interventions' effectiveness is mixed and varies according to the type of medium utilised or on the type of communication strategy utilised (Neuhauser & Kreps, 2010). In 2003, Neuhauser and Kreps (2003) in a narrative review reported that overall e-health interventions had shown positive effects on dietary behaviours and physical activity, even though the number of studies was limited and the effects were small (Neuhauser & Kreps, 2003). Similar conclusions were drawn by Kroeze, Werkman and Brug (2006), who systematically reviewed the literature, published between 1965 and 2004, on computer-tailored randomised trials targeting physical activity education and dietary behaviours. They included in the review 30 studies, 11 of which dealt with physical activity. Many of these studies reported significant effects on physical activity, but were associated with small effect sizes. The authors concluded that the evidence for the effectiveness of computer-tailored interventions was quite strong, even though the effect sizes were small and limited in time (Kroeze, Werkman, & Brug, 2006).

Two contemporaneous systematic reviews about web-based interventions (van den Berg, Schoones, & Vliet Vlieland, 2007; Vandelanotte, Spathonis, Eakin, & Owen, 2007) revealed mixed results regarding the effectiveness of web-based interventions. For instance, Vandelanotte and colleagues (2007) found that eight out of 15 studies included in the review showed improvements in physical activity, with effect sizes ranging from .13 to .67 (mean effect size = .44). However, the effects were found to be short lived, as they diminished after six months (Vandelanotte et al., 2007). Instead, van den Berg, Schoones, and Vliet Vlieland (2007) found that in two out of three studies analysed, the Internet intervention showed significant improvements in physical activity compared with similar participants on a waiting list. However, in four other studies, the evidence was inconclusive suggesting that definitive conclusions on the effectiveness of web-based interventions could not be reached (van den Berg et al., 2007). Similar results were found in a web-based RCT targeting multiple behaviours and health risk factors, such as physical activity, dietary practices, and stress (Cook, Billings, Hersch, Back, & Hendrickson, 2007). The authors found significant differences for attitudes towards healthy diet and dietary stage of changes, but no significant differences between the intervention (web-based communication) and the control group (print materials) for stress and physical activity indicators (Cook et al., 2007).

A general review on e-health interventions addressing both physical activity and diet was conducted by Norman and colleagues (2007). They explored the literature published between 2000 and 2005, investigating the results of 49 studies. Of these, 13 studies focused only on physical activity, 16 only on dietary behaviours and 20 on both behaviours, including an extension of weight loss programmes. The authors found that the most commonly used e-health components were websites and e-mails, in combination or in isolation. One study used a CD-ROM and another one utilised a computer-automated telephone system. Results of the interventions focusing on physical activity showed mixed results: three studies found positive effects on behaviour, whereas six could not determine an effect, and in one study the control group had higher levels of physical activity compared to the intervention group. The 20 studies that addressed both dietary and physical activity behaviours used websites, computers or kiosks or e-mails as e-health components. Of 17 articles that measured physical activity, six reported significant effects of the intervention. Overall, 11 out of 20 studies found sufficient evidence in favour of the interventions on physical activity, dietary behaviour or weight loss, however the effect sizes were generally small to moderate (r ranged from -.03 to .43 for physical activity interventions). The authors suggested that e-health interventions could be effective in influencing physical activity behaviour, however, the reviewed studies that isolated the technology component in the design revealed smaller effect sizes than those which did not isolate the component. This suggested that e-health interventions did not have higher efficacy than any other intervention (Norman et al., 2007).

In 2009, Neville, O'Hara and Milat (2009) conducted a narrative systematic review of studies published between 1996 and 2008, focusing on primary prevention computer-tailored interventions. They reported that 10 out of the 17 articles included, had significant positive effects on physical activity and weight reduction outcomes. However, considered the inconsistency of the findings, and the reported issues related to validity and generalizability (i.e., self-selection bias in many studies, self-reported behaviour, limited evidence of long-term effects), the authors stated that the evidence was inconclusive (Neville et al., 2009).

More recently, Krebs, Prochaska and Rossi (2010), in a meta-analysis on computer-tailored intervention studies published between 1988 and 2009, found that the overall effect size of 88 tailored interventions was small to medium (g = .17, 95% CI: .14 to 19), where g = .15, .20 and .25 for small, medium and large effects, as reported by the authors (Krebs, Prochaska, & Rossi, 2010, p. 219). The highest effect size was found in studies addressing dietary fat reduction (26 studies; g = .22; 95% CI: .18 to .26). For physical activity, the average effect size was g = .16 (25 studies; 95% CI: .10 to .21), similar to smoking cessation and fruit and vegetable consumption (Krebs et al., 2010). Finally, Webb et al. (2010) evaluated the effects of internet-based interventions on health-related behaviour. They found that on 85 studies reviewed, the average weighted effect size across all interventions was d = .16 (95% CI: .09 to .23), suggesting a small effect on health behaviour. For physical activity interventions, the effects were significant, but small: 20 studies; d = .24, 95% CI: .09 to .38 (Webb, Joseph, Yardley, & Michie, 2010).

Periodic prompts and text messaging

The role of periodic prompts in health behaviour interventions was investigated in a systematic review by Fry and Neff (2009). The authors reviewed 19 articles, published between 1988 and 2008, reporting on 11 studies. Of the 19 articles, 11 reported generally positive findings. The authors suggested that the evidence was positive, but not entirely conclusive or consistent. Several articles reported higher effects when prompts were frequent (i.e., once a week vs. once every three weeks) and were associated with counselling. However there was no difference in the medium utilised for delivering prompts (Fry & Neff, 2009). These findings are consistent with those found in the specialised workplace health promotion literature. For instance, in Dugdill et al.'s (2008) review, two studies promoting physical activity through e-mail prompts (Marshall et al., 2003; Plotnikoff et al., 2005) showed contrasting findings. Plotnikoff et al. (2005)

reported significant increase in physical activity for employees who received health messages via e-mail as opposed to a control group. Marshall et al. (2003) found no significant increase in total reported physical activity within or between groups when analysed by intention to treat analysis. Based on these findings, Dugdill et al. concluded that the evidence for effectiveness of e-mail messages was inconclusive (Dugdill et al., 2008).

Two reviews published in the last three years explicitly investigated the use of text messaging in health communication. Krishna, Boren and Balas (2009) reviewed the literature on interventions utilising mobile technology in health care. Twelve of 13 studies measured and reported significant changes in clinical outcomes, as a result of voice or text messages sent to a cell phone. Nine studies assessed the effectiveness of using cell phones on diabetes control and management, one on asthma, and one on hypertension. Other clinical areas covered by clinical improvement studies included stress management and physical activity. The only one study dealing with physical activity was Hurling et al.'s study (2007). Overall, they found that information and education interventions delivered through wireless mobile technology resulted in significant improvements in the majority of studies. Interventions targeting chronic diseases (e.g., diabetes and asthma), which require regular management, and smoking cessation, which require continuous advice and support, were considered the most effective approaches (Krishna et al., 2009).

Similar results were found in Cole-Lewis and Kershaw's review (2010), which focused on text messaging for health promotion. The authors analysed 17 articles presenting 12 studies, the majority of them targeting disease prevention, preventive medication adherence, weight-loss, smoking cessation and physical activity. The majority of the studies reported evidence to support the effectiveness in the short-term for behavioural and clinical outcomes associated with disease prevention and management (such as diabetes management, weight loss and smoking cessation). However the studies found no effect for physical activity behaviour (Cole-Lewis & Kershaw, 2010).

2.7 The Theory of Planned Behaviour

The Theory of Planned Behaviour (TPB) is a social-cognitive theory, initially developed from the joint work of two researchers, Ajzen and Fishbein, who, based on studies on behaviour and its social and cognitive determinants, in the early 1980s developed a theoretical framework called Theory of Reasoned Action (Ajzen & Fishbein, 1980). The TRA postulated that behaviour was a function of intention, which in turn was a function of attitudes toward the behaviour and social norms. Fishbein applied the theory in various settings and in particular in HIV prevention research, whereas Ajzen's research was based on laboratory tests aimed at refining the model. Having recognised that not all behaviours are under complete volitional control (i.e., when intention is weakly related to behaviour), Ajzen introduced the concept of perceived behavioural control (PBC) as a predictor of both intention and behaviour (Ajzen, 1985, 1991). He suggested that PBC should facilitate the implementation of intentions into action and argued the presence of a direct relationship between PBC and actual behaviour (Armitage & Conner, 2001). This extension of the TRA became the Theory of Planned Behaviour (TPB) and in the following years it has been developed independently as an extended version of the TRA. According to Ajzen (1991), behaviour is a function of cognitive and social processes which determine the likelihood to perform that behaviour. He suggested that behavioural intentions are the primary determinants of behaviour and intentions are in turn influenced by three constructs, perceived behavioural control, attitudes towards the behaviour and subjective norms. The Theory of Planned Behaviour model (as depicted in Fig 2.7.1) is composed of these four constructs (plus behaviour). In other terms, the relationship between attitudes, subjective norms and perceived behavioural control with actual behaviour is mediated by behavioural intention.

More recently, the two authors presented an updated and evidence-based version of the two theories which converged in their Reasoned Action Approach (Ajzen & Fishbein, 2010). The Reasoned Action Approach builds on more than 45 years of studies conducted jointly and independently by Ajzen and Fishbein and by other researchers which tested the incorporation of other more stable variables to improve the predictive utility of the model. Some included more stable traits such as personality (e.g., Chatzisarantis & Hagger, 2008; McEachan, Sutton, & Myers, 2010; Rhodes & Courneya, 2003a, 2003b), others investigated the addition of self-efficacy and past behaviour as predictors of actual behaviour (e.g., Araújo-Soares, McIntyre, & Sniehotta, 2009; Hagger & Chatzisarantis, 2009; Hagger, Chatzisarantis, & Biddle, 2002a; Hagger, Chatzisarantis, Biddle, & Orbell, 2001; Rhodes & Courneya, 2003c); others investigated the role of anticipated regret[7] (e.g., Abraham & Sheeran, 2003, 2004; Sandberg & Conner, 2008) and others tested extended models including other variables, such as perceived need (Fen & Sabaruddin, 2009), or merged the TPB with other behaviour change models and focusing on different cognitive and emotional aspects (e.g., Conner & Armitage, 1998; Hamilton & White, 2008; Jackson, Smith, & Conner, 2003; Mohiyeddini, Pauli, & Bauer, 2009).

The Reasoned Action Approach encompasses the core TPB constructs (attitudes, subjective norms, perceived behavioural control, intention and behaviour), the predictors of attitudes, perceived behavioural control and subjective norms (i.e., behavioural beliefs, normative beliefs and control beliefs), and background factors, classified as individual, social, and information factors. Individual factors include for example personality, mood, emotions, general attitudes, past behaviour; social factors include cultural and socio-demographic variables (i.e., age, gender, education, income, religion, culture); information factors include, among others, knowledge, media influence and intervention (Ajzen & Fishbein, 2010).

There are not many differences between the TPB and the Reasoned Action Approach model, as conceptualised by Ajzen (1991), so in this dissertation, literature reviews and other related findings are referred to Ajzen's original TPB model, with some integrations and updates from the revised approach, where available.

[7] Anticipated regret is an emotive predisposition, based on "beliefs about whether or not feelings of regret or upset will follow from inaction (e.g. 'I would regret it if I did not exercise tomorrow')" (Abraham & Sheeran, 2003, p. 496).

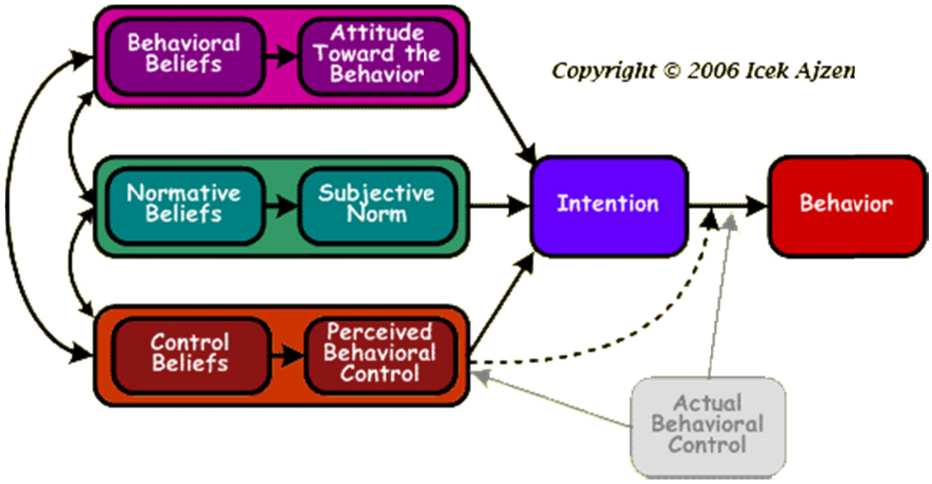

Figure 2.2. The Theory of Planned Behaviour Model diagram by Icek Ajzen

2.7.1 TPB constructs and definitions

Behavioural intention is defined as the "readiness to perform a given behaviour" (Ajzen & Fishbein, 2010, p. 39) and it is considered to be the immediate antecedent of behaviour. In other terms, intention corresponds to an individual's estimate of the likelihood that a specific behaviour will be performed in a certain timeframe.

Perceived behavioural control is defined as "people's perceptions of the degree to which they are capable of, or have control over, performing a given behaviour" (Ajzen & Fishbein, 2010, p. 64). The antecedents of perceived behavioural control are control beliefs, which are based on the perception that one has or does not have the ability to carry out the behaviour (Ajzen & Fishbein, 2010).

Attitude in general is defined as a "latent disposition or tendency to respond with some degree of favourableness or unfavourableness to psychological objects", but the attitude object can be "any discriminable aspect of an individual's world, including behaviour" (Ajzen & Fishbein, 2010, p. 76). In other terms, attitudes are global positive or negative evaluations about certain behaviour. In general, the more positive the attitude, the stronger the intention to perform that behaviour would be (Armitage & Conner, 2001). Based on the Expectancy-Value Model of attitude, Ajzen and Fishbein conceptualised beliefs as antecedents of attitudes. Beliefs are defined as "the subjective probability that an object has a certain attribute (Ajzen & Fishbein, 2010, p. 96). In the case of attitudes towards a given behaviour, beliefs become behavioural beliefs, as they are related to a specific behaviour.

Subjective norms or ‘perceived social pressure’, as it is conceptualised in the latest Ajzen and Fishbein’s book (2010), is the “perceived social pressure to perform (or not to perform) a given behaviour” (Ajzen & Fishbein, 2010, p. 130). The concept was introduced in the initial formulation of the reasoned action approach as social norm, defined as “an individual’s perception that most people important to them think they should (or should not) perform a specific behaviour” (Ajzen, 1991; Ajzen & Fishbein, 1980). Over the years, it became clear to the authors that peer pressure could manifest in two ways: first, as the individual’s perceptions towards what other people think they should do; second, as the perception of what other people actually do. This distinction is between injunctive and descriptive norms. Injunctive norms are “the perceptions concerning what should or ought to be done with respect to a given behaviour”, and descriptive norms refer to the perceptions that others are or are not performing the behaviour (Ajzen & Fishbein, 2010, p. 131). In the TRA and TPB, the concept of subjective norm included only injunctive norms, whereas the updated version of the theory encompasses both injunctive and descriptive norms with appropriate ways to measure them (Ajzen, 2006a, 2011; Ajzen & Fishbein, 2010). As determinants of injunctive norms are normative beliefs, defined as beliefs that specific individuals or groups think one should or should not perform the behaviour in question (Ajzen & Fishbein, 2010).

2.7.2 Application of the TPB to physical activity

The fortune of the Theory of Planned behaviour is various and large, as testified by the large number of citations reported in Ajzen (2011): from 22 citations in 1985, has grown to a stable total of 4550 in 2010. However, the theory is not only supported by extensive empirical evidence, but also by relevant meta-analyses that synthesised the evidence. In fact, several meta-analyses and systematic reviews consistently supported its good predictive utility and applicability in various health behaviours, including, for example, smoking, sexual behaviour, exercise, food choice and dietary behaviours (Armitage & Conner, 2001; Godin, 1993; Godin & Kok, 1996; Hausenblas, Carron, & Mack, 1997; McEachan, Conner, Taylor, & Lawton, 2011; Symons Downs & Hausenblas, 2005a).

Concerning physical activity behaviour, Godin and Kok (1996) in their meta-analysis found that the model explained on average 41% of the variance in intention and 34% in health-related behaviour, and PBC contributed to an additional 13% of explained variance in intention and 12% in behaviour (Godin & Kok, 1996). Similar results were found in a meta-analysis by Armitage and Conner (2001). Findings showed that, across 185 empirical tests on various behaviours, the average multiple correlation of intention and PBC with behaviour was .52, accounting for 27% of the variance. The inclusion of PBC in the model added up to 2% of the variance in behaviour, over and above intention. The whole model, including attitudes, subjective norms, and PBC accounted for 39% of the variance in intention (Armitage & Conner, 2001).

The TPB has also been extensively applied in the physical activity domain. Numerous systematic reviews and meta-analyses have been published over the past 20 years testing the effect of the TPB in predicting exercise behaviour. Various reviews found results that are comparable to those found in general meta-analyses on TPB. For example, McAuley and Courneya (1993) reviewed the literature on TPB and TRA research investigating the adherence to exercise. Overall, they found that the proportion of variance explained in behaviour due to intention ranged between 10% and 67%, with the overall model (PBC, subjective norms, and attitudes) explaining from 24% to 66% of the variance in intention (McAuley & Courneya, 1993).

Also Hagger, Chatzisarantis and Biddle (2002b) conducted a meta-analysis of studies using the TPB in the physical activity domain. The authors included also extended variables components of self-efficacy and past-behaviour across studies using the TPB and the TRA. The authors provided an exemplar application of path analysis (a component of SEM) to a meta-analytic approach testing the causal relationships between variables in the model and assessing their magnitude. They found that the TPB model accounted for 44.5% of the variation in intention, and PBC alone accounted for 15% of the variation in behaviour. Overall, the TPB accounted for 22.4% of the variation in behaviour (Hagger, Chatzisarantis, & Biddle, 2002b). Similar results, in terms of proportion of variance explained by the TPB model, were found in a study by Armitage (2005), who used TPB to predict participation in physical activity among members of a fitness club. The TPB model predicted 49% of the variance in intention to exercise and 22% of the variance in behaviour, but only PBC was found to be a significant independent predictor of behaviour (Armitage, 2005).

The predictive utility of the TPB model was confirmed also in another recent meta-analysis (McEachan et al., 2011), which aimed at exploring the efficacy of the Theory of Planned Behaviour depending on behaviour type and other methodological moderators (i.e., length of follow-up, sample age and behavioural measure). The authors found that the TPB model explained the 23.9% of the variance in physical activity (McEachan et al., 2011).

There are many examples of studies testing the TPB in the physical activity domain, but most of these were conducted with populations of undergraduate or graduate students (e.g., Blanchard et al., 2007; Chatzisarantis, Frederick, Biddle, Hagger, & Smith, 2007; Hagger, Chatzisarantis, & Harris, 2006; McEachan et al., 2010; Scott, Rhodes, & Symons Downs, 2009; Wang, 2011), adolescents or teenagers (e.g., Hagger et al., 2007; Hagger, Chatzisarantis, Biddle, & Orbell, 2001; Plotnikoff et al., 2011), or with adults living with different health conditions, such as diabetes (e.g., Plotnikoff et al., 2010; Plotnikoff, Trinh, Courneya, Karunamuni, & Sigal, 2011), obesity (e.g., Godin, Amireault, Belanger-Gravel, Vohl, & Perusse, 2009), heart failure (e.g., Blanchard et al., 2003; Blanchard, Courneya, Rodgers, Daub, & Knapik, 2002), and various cancers (e.g., Blanchard, Courneya, Rodgers, & Murnaghan, 2002; Karvinen et al., 2007).

Few examples of studies were conducted with adult and healthy participants. A study by Gretebeck and colleagues focused on a population of older adults (Gretebeck et al., 2007), whereas other authors investigated active travel and the role of behavioural habit and repeated behaviour among adults (e.g., de Bruijn, Kremers, Singh, van den Putte, & van Mechelen, 2009; Rhodes, de Bruijn, & Matheson, 2010). A very recent work by Plotnikoff and colleagues (2012) investigated the determinants of physical activity over a period of 15 years among a subsample of adults participating in the 1981 Canada Fitness Survey (Plotnikoff, Lubans, Trinh, & Craig, 2012). Plotnikoff et al. found that the variance explained by the TPB variables in behavioural intention ranged from 21% to 29%, and that the variance in physical activity ranged from 9% to 22% over the selected timeframe, with attitudes being the strongest predictor of intention over time (Plotnikoff et al., 2012).

Within a population of employees, some studies analysed different health behaviours, such as alcohol consumption (e.g., Hagger et al., 2012; Hagger, Lonsdale, & Chatzisarantis, 2011), or smoking cessation (Hu & Lanese, 1998; Willemsen, de Vries, van Breukelen, & Oldenburg, 1996), but only a small number of studies used the TPB as model to predict physical activity behaviour in the workplace. Most of these studies date back to the 1990s and early 2000s (e.g., Biddle, Goudas, & Page, 1994; Blue, Wilbur, & Marston-Scott, 2001; Godin & Gionet, 1991; Kimiecik, 1992).

The studies testing the TPB in the physical activity domain in the workplace setting showed results consistent with the findings of the meta-analyses reported so far. For example, a study conducted among employees of an electric power's commission, discovered that the TPB model explained 41.4% of the variance in the behavioural intention (Godin & Gionet, 1991). They also found that habit (i.e., repeated behaviour in the past) explained the 44% of the variance in intention to exercise, whereas perceived barriers to exercise and attitudes respectively explained the 28% and the 21% of the variance in intention (Godin & Gionet, 1991). In a study with blue-collar workers, Blue, Wilbur and Marston-Scott (2001) found that attitude toward exercise and perceived behavioural control explained a larger proportion of variance in intention (61.7%). Intention and perceived behavioural control explained 51.3% of the variance in physical activity behaviour, whereas subjective norm was not a significant predictor of intention to exercise (Blue, Wilbur, & Marston-Scott, 2001). These studies showed that the TPB was a good predictor of intention and behaviour, but targeted specific types of employees (i.e., blue collar workers, electric power plant employees). Not many studies extended the investigations and testing of the TPB to a broader range of employed workforce. For example, only one study investigated the social-cognitive determinants of physical activity among a university population (Biddle et al., 1994), but focused on leisure-time physical activity. Little is known about the postulated socio-cognitive determinants of physical activity across various activity domains (e.g., leisure-time, work-related, active transportation, domestic and garden) in a broader range of employees, including those working in large academic institutions, small to medium service enterprises or other types of organisations.

2.7.3 Effectiveness of the TPB and behaviour change

Although Ajzen hypothesised that TPB could serve as the basis of behaviour change interventions (Ajzen, 2006b; Ajzen & Manstead, 2007; Fishbein & Ajzen, 2005), there is a paucity of research that questions or tests hypotheses related to this fundamental proposition in the context of health communication interventions. The fact that the TPB could serve as theory of behaviour change is questioned in the literature. For instance, Michie and Abraham (2004) noted that even if the theory has been applied in many studies addressing various health behaviours, it “has not been systematically evaluated as an explanation of behaviour change” (Michie & Abraham, 2004, p. 34). Suggestive results about the effectiveness of TPB-based interventions were found in Hardeman and colleagues’s (2002) meta-analysis. They reviewed 30 papers describing 24 interventions. The majority of these targeted health-related behaviours (i.e., sugar intake, smoking cessation, exercise, testicular self-examination, and drink driving). They reported that a variety of techniques were used in intervention studies drawing on the TPB, including verbal persuasion, goal setting, rehearsal of skills, modelling, and planning (Hardeman et al., 2002). The authors noted that all interventions used the TPB for measurement purposes, half of them adopted the TPB to design the intervention itself and half of them investigated changes within or between groups (Hardeman et al., 2002). Regarding the effectiveness in changing intentions, Hardeman et al. found that about half of the studies that evaluated interventions reported on change in intention, but effect sizes were generally small. Regarding the effectiveness in changing behaviour, the authors found that the intervention resulted in some change in the positive direction, and the effect sizes were small to moderate, especially for interventions designed with the TPB (Hardeman et al., 2002).

More recently, Rhodes and Pfaeffli (2010) reviewed the literature investigating mediation in physical activity behaviour change among adults. Only three studies employed the TPB: two of these studies, however, showed null results in terms of a link between the intervention and physical activity as well as a link between the intervention and TPB constructs. Overall, the authors concluded, “the evidence is too limited from a paucity of research and lack of actual behaviour change in the interventions to make a judgement of the effectiveness of TPB as a mediator in physical activity interventions” (Rhodes & Pfaeffli, 2010, p. 6).

In the already mentioned review by Webb et al. (2010) on the effects of internet-based interventions on health-related behaviour, the authors found that interventions based on the TPB tended to have higher effects on behaviour (nine studies; $d = .36$, 95% CI: .15 to .56) than did interventions based on other theoretical frameworks, such as the Transtheoretical Model and Social Cognitive Theory (Webb et al., 2010). It has to be noted that the author of the theory did not claim it as behaviour change theory. In fact, in Ajzen and Manstead’s sustained that: “the model was never intended to serve as a theory of belief change, and there are of course several theories of attitude change available that can be used to design effective interventions” (Ajzen & Manstead, 2007, p. 52). Ajzen and Manstead suggested that other persuasive techniques and models of attitudinal and behavioural change can be used to influence the variables in the model.

One example of a combination of TPB designed intervention and persuasive approach in the exercise domain is offered by Jones and colleagues’ (2004) experiment. They tested an intervention encouraging exercise motivation in college students using positively framed (attribute framing) messages and measures derived from Petty and Cacioppo’s (1981, 1984) Elaboration Likelihood Model (ELM). However, the authors found no significant effects between experimental and control conditions over the duration of the intervention (2 weeks) on any psychological or behavioural variable related to the TPB (Jones, Sinclair, Rhodes, & Courneya, 2004).

Different results were reached in a similar experimental study by Parrott, Tennant, Olejnik and Poudevigne (2008). They tested the use of positively- versus negatively-framed messages delivered through e-mail among college students. Participants were randomly allocated in the positively-framed group, negatively-framed group and control group. Participants in the intervention groups received persuasive messages every other day for two weeks. Outcomes were measured at the end of the intervention and one week later. Results showed that, overall, positively-framed messages sent via email improved exercise behaviour and that both types of messages affected attitude, and intention in the sample (Parrott, Tennant, Olejnik, & Poudevigne, 2008). In particular, they found that those who received positively-framed messages had a significant increase in physical activity levels at immediate post-test and one-week follow-up as opposed to both negatively-framed and control groups. For behavioural intention and attitudes, both positively-framed and negatively-framed reported significantly higher levels than control group at post-test follow-up and only positively-framed group scored higher in intention than the others one week later (Parrott et al., 2008).

A more recent example of non-significant prediction of the theory in exercise domain was reported in Hardeman, Kinmonth, Michie and Sutton's study (2011). They adopted a RCT design for attitudes and perceived behavioural control. They found that these factors consistently predicted intention, but intention and perceived behavioural control failed to predict physical activity levels or change (Hardeman, Kinmonth, Michie, & Sutton, 2011).

2.7.4 The TPB in this dissertation

In this dissertation, the model depicted in Figure 2.3 will be used for testing predictive utility of the Theory of Planned Behaviour. The lines and arrows represent relationships and the direction of the relationships with the variables in the model. The dashed line between PBC and behaviour is included as initially proposed by Ajzen (1991). The additional path between PBC and behaviour might become significant in conditions of weak volitional control, in other words when intentions do not significantly predict behaviour (Armitage & Conner, 2001).

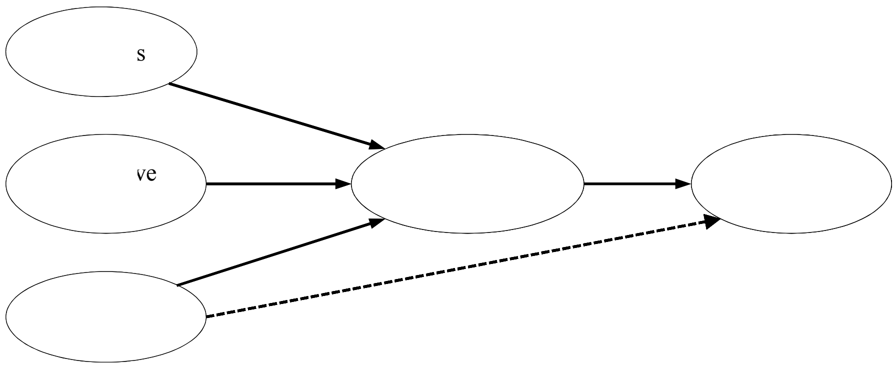

Figure 2.3. Basic TPB model tested in this dissertation

2.8 Summary and research gaps

Based on the findings outlined in this literature review, the following research gaps can be outlined. First, from a theoretical point of view, the Theory of Planned Behaviour has shown good predictive utility on physical activity behaviour and it has been used extensively in physical activity studies. However, only a small number of studies used communication as an intervention to increase physical activity, and only few used TPB-based physical activity communication interventions delivered by e-mail and text messaging in the workplace.

Second, theory-based interventions targeting physical activity in the workplace using information and communication technologies showed overall positive results, even if the effects were small and short lived. Various reviews (e.g., Bennett & Glasgow, 2009; Fry & Neff, 2009; Kreps & Neuhauser, 2010; Neville et al., 2009) suggested that internet-based and ICT-based interventions offer great potential, but the use of new technologies in a workplace health promotion intervention targeting physical activity has not yet been investigated thoroughly. Little is known on the type of media strategy that could be chosen to engage employees and persuade them to become more physically active.

Third, a key issue in workplace health promotion programmes is increasing or maintaining high participation rates, and there is a paucity of research that investigated the reasons for participating and non-participating in workplace physical activity interventions.

2.9 Objectives and research questions

Based on the research gaps previously outlined, the objectives of this dissertation, the relative research questions (RQs) and research hypotheses (RH) can be summarised as follows:

Objective one

Test the Theory of Planned Behaviour and investigate its predictive utility of physical activity behaviour in a workplace setting.

RQ1: *Is the Theory of Planned Behaviour a good predictor of behaviour among employees who participate in a theory-based and technology-based intervention encouraging physical activity in the workplace?*

RH1: The theory of planned behaviour will be confirmed as significant predictor of intentions to perform physical activity behaviour and physical activity among employees participating in a technology-based intervention encouraging leisure-time and workplace physical activity.

Objective two

Test the effects of a theory-based and technology-based intervention promoting leisure-time and workplace physical activity among employees, utilising persuasive e-mail communication and SMS prompts.

RQ2: *To what extent are e-mails and text messages capable of influencing physical activity behaviour of employees participating in the MoveM8 programme?* Or otherwise stated: *What intervention group will show better outcomes (in terms of changes in TPB constructs and physical activity) after the intervention?*

RH2: Based on the findings of the literature about motivational prompts and text messages, participants who received SMS in addition to the weekly e-mail will have larger magnitude of change between pre- and post-intervention assessments on physical activity behaviour, or other TPB constructs (attitudes, subjective norms, perceived behavioural control, or intention) than those who did not receive SMS.

Objective three

Examine eligible employee's reasons for participating or not participating in a technology-based intervention.

RQ3: *Why employees decided to participate (or not to participate) in the intervention?*

RH3: Participants chose to participate or not to participate on the basis of a combination of factors, including personal characteristics (such as preferences towards technology, perceived needs and expectations towards the programme, etc.), and "environmental factors", such as organizational support, presence of fitness facilities, etc.

2.10 List of abbreviations

AHA	American Heart Association
ACSM	American College of Sports Medicine
BHFNC	British Heart Foundation National Centre for Physical Activity and Health
BIS	Business Innovations and Skills (Department of) - (UK)
BMI	Body mass index (kg/m^2)
CDC	Centres of Disease Control and Prevention
CEO	Chief Executive Officer
CFA	Confirmatory factor analysis
CHD	Coronary Heart Disease
CHF	Swiss Franc (Chf)
CI	Confidence interval
CLES	Common Language Effect Size
CR	Critical ratio or construct reliability (defined in context)
CSR	Corporate social responsibility
CT	Controlled Trial
CVD	Cardiovascular Disease
DALY	Disability Adjusted Life Years
DH	Department of Health (UK)
ELM	Elaboration Likelihood Model
GBP	Pounds sterling (£)
HBM	Health Belief Model
HRA	Health Risk Assessment or Health Risk Appraisal
ICT	Information and Communication Technology
ILO	International Labour Organisation
IOM	Institute of Medicine
IPAQ	International Physical Activity Questionnaire
ISPAH	International Society for Physical Activity and Health
LTPA	Leisure time physical activity
NCD	Noncommunicable disease

NCI	National Cancer Institute
NHS	National Health Services (UK)
NICE	National Institute for Health and Clinical Effectiveness (UK)
OHA	Occupational health adviser
OLS	Ordinary Least Squares
ONS	Office of National Statistics (UK)
OR	Odds Ratio
PA	Physical activity
PCT	Primary Care Trust
QALY	Quality adjusted life year
RCT	Randomised Controlled Trial
RR	Risk Ratio
SCT	Social Cognitive Theory
SLT	Social Learning Theory
SEM	Structural Equation Modelling
SME	Small to Medium Enterprise(s)
TPB	Theory of Planned Behaviour
TTM	Transtheoretical Model
TRA	Theory of Reasoned Action
USD	U.S. Dollar ($)
USPSTF	U.S. Task Force on Community Preventive Services
WHO	World Health Organisation
WHP/P/I	Workplace Health Promotion / Programme / Intervention
WPA	Workplace physical activity
WPAI	Workplace physical activity interventions

CHAPTER THREE
METHODOLOGY

CHAPTER OUTLINE

3.1 The MoveM8 research project

In response to the public health need and to the specific U.K. governmental priorities for health promotion in workplaces, the MoveM8 project was developed by a team of researchers based at the Università della Svizzera italiana, in collaboration with the University of Nottingham. Integral part of the research project was the "*MoveM8 programme*", a 12-week e-mail and text messaging (SMS) physical activity communication intervention promoting leisure-time (LTPA) and workplace physical activity (WPA) among employees of organisations situated in the United Kingdom. The MoveM8 programme, whose design was based on the Theory of Planned Behaviour, was conducted between September 2009 and August 2010. The protocol of the intervention[8] was approved by the University of Nottingham Medical School Ethics Committee [Ethics Reference No: D/3/2009]. Additionally, to investigate the reasons for participation and non-participation in the MoveM8 programme, a qualitative investigation, using interviews and focus groups, was conducted between June and July 2011[9]. The protocol of the interviews was approved by the University of Nottingham Medical School Ethics Committee [Ethics Reference No: F/3/2011]. The project timeline is graphically summarised in Figure 3.1.

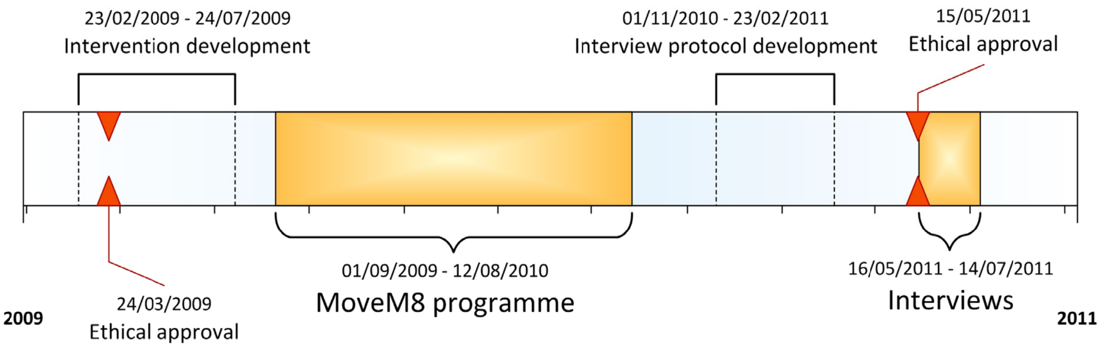

Figure 3.1 The MoveM8 project timeline

[8] The protocol was titled: "*Tailored physical activity communication in the workplace: a test of the Theory of Planned Behaviour and persuasive communication strategies*".
[9] The protocol was titled: "*Reasons for participation in a persuasive communication intervention for physical activity promotion: the MoveM8 programme evaluation*" and was carried out with the support of a grant by the Swiss National Science Foundation (PBTIP1-135856).

This chapter describes the methodology utilised in this dissertation to fulfil the objectives and answer the research questions. This dissertation had three main objectives: the first was to test the Theory of Planned Behaviour (Ajzen, 1991) and investigate its predictive utility of physical activity behaviour in a workplace setting; the second was to test the effects of the MoveM8 programme on TPB constructs (i.e., attitudes towards the behaviour, subjective norms, perceived behavioural control and behavioural intention), and on physical activity behaviour; the third was to examine employees' reasons for participating and not participating in the MoveM8 programme.

To fulfil the objectives and answer the research questions (outlined in Chapter Two, paragraph 2.9), a combination of quantitative and qualitative techniques was used. The first two objectives were achieved through the use of quantitative data collected through pre- and post- intervention surveys. The first two objectives were pursued using structural equation modelling (SEM) techniques. The third objective was pursued using the analysis of interviews and focus groups conducted with employees who participated and who did not participate in the MoveM8 programme.

The MoveM8 research project is based on a mixed-methods approach (Creswell, 2009; Creswell & Plano Clark, 2007), as it combined qualitative and quantitative components for the broad purposes of "breadth and depth of understanding and corroboration" (Johnson, Onwuegbuzie, & Turner, 2007, p. 123). For instance, the contents of the MoveM8 intervention were designed according to the results of a qualitative phase, also defined as formative research (Atkin & Freimuth, 2001), which included elicitation surveys with the target population and content validation through a multi-stage web-based Delphi approach. The survey instruments, based on the Theory of Planned Behaviour, were designed on the basis of elicitation interviews with the target population, following literature recommendations (Ajzen, 2006b; Francis et al., 2004; Symons Downs & Hausenblas, 2005b).

3.2 Development of the intervention and TPB survey

The MoveM8 programme was based on a randomised controlled trial (RCT) design with two study groups, and was modelled on a similar study which used e-mails to promote physical activity in workplaces in Canada (Plotnikoff et al., 2005). The first intervention group received one personalised e-mail message every week, for 12 weeks, whereas the second intervention group received one personalised e-mail and two standard SMS text message reminders every week for 12 weeks. Since there are no clear guidelines on the duration of interventions (e.g., van den Berg et al., 2007), the duration of the intervention was set to 12 weeks, as in the model study (Plotnikoff et al., 2005). Participants were randomly assigned to one of the two intervention groups, upon completion of a baseline assessment.

The intervention development was guided by the Theory of Planned Behaviour (see Chapter Two, paragraph 2.7). The TPB was used in this study to develop the content of the intervention and the TPB assessments utilised to assess TPB constructs as predictors of physical activity behaviour. The content of the intervention was developed by the research team on the basis of formative research conducted with the target population (Ajzen, 2006b; Ajzen & Manstead, 2007) and was designed to influence TPB constructs (attitudes, subjective norms, perceived behavioural control and behavioural intention). E-mail messages addressed the most relevant beliefs and barriers, associated with the core constructs of the Theory of Planned Behaviour, which were identified within the study population during the elicitation phase.

3.2.1 Formative research phase

In behavioural research, as Atkin and Freimouth suggest (2001), formative research should be usually conducted with a small sample of the target population to determine: a) the most frequently perceived advantages and disadvantages of performing physical activity; b) the most important people or groups of people who would approve or disapprove the behaviour; c) the perceived barriers and facilitators to adopt the behaviour. This research approach is helpful because it provides a deep insight of the target population, which can foster the creation of content that might be perceived as more relevant and in line with people's needs and ideas. Some studies in the physical activity research domain used formative research to develop health promotion programmes and include, for example, a workplace health promotion programme for African American women (Zunker et al., 2008) and a physical activity intervention for children (Mackintosh, Knowles, Ridgers, & Fairclough, 2011).

Elicitation studies are common practice in developing TPB-based interventions, as reported in a review by Symons Downs and Hausenblas (2005). In addition to the identification of perceived barriers and benefits to a given behaviour, elicitation studies are also recommended for the development of a proper survey instrument that is based on the Theory of Planned Behaviour. In fact, according to TPB methodological literature (Ajzen, 2006a; Francis et al., 2004), elicitation interviews conducted with the target population should help identifying relevant and salient antecedents of the core TPB constructs, namely behavioural beliefs, normative beliefs or sources of social pressure (reference individuals or groups), and control beliefs. In fact, according to the TPB model (see Figure 2.2), behavioural, normative and control beliefs indirectly influence attitudes, subjective norms and perceived behavioural control respectively. Further details about TPB survey development are presented in paragraph 3.2.6.

Formative research was conducted with a convenience sample of employees (n = 21) working in the first three organisations that were involved in the study (Stockton Riverside College, Avecia Bilogics Ltd. – now Fujifilm Diosynth –, and University of Nottingham). As suggested by the literature (Ajzen, 2006a; Francis et al., 2004), participants were asked, in an open-ended format, to identify and describe the advantages and disadvantages of "getting at least 30 minutes of moderate or 20 minutes of vigorous physical activity on at least 5 days in the coming week". Then, they had to indicate what individuals or groups would have approved or disapproved their behaviour. They were also asked to identify factors or circumstances that would facilitate or hinder their behaviour.

Thematic analysis of the answers revealed that the most salient perceived benefits or advantages of doing physical activity concerned the following dimensions: *overall* *fitness and general health improvement* (e.g., "it keeps you fit and healthy" or "it keeps the body in good working order"); *healthy organs* (e.g., "maintain bone density", "it keeps your heart healthy", and "improves blood circulation"); *weight control (*e.g., "helps burn up excess calories", or "increased fitness leading to weight loss"); *improved mood* and *positive feelings* (e.g., "makes you feel good", "feel better about myself"); *improved alertness and concentration* (e.g., "increased concentration", "good for the mind", "more concentration", "makes you feel more alert"); and *stress relief* (e.g., "relieves from stress").

The themes related to the perceived barriers to physical activity were *time and workload* (i.e., the lack of time to fit physical activity into daily schedules especially when working full-time in busy periods); *presence of illness* (e.g., "having a cold"); *psychological barriers*, such as lack of motivation, feeling tired or fearing to get injured; and *environmental factors*, such as absence of facilities (e.g., showers, rest-rooms for changing clothes after physical activities), or bad weather conditions.

Among the factors enabling physical activity, respondents mentioned *internal motivating factors*, such as personal positive mental attitudes and motivation, and the possibility of having *flexible time at work*. Concerning the most important people who influenced their behaviour, participants frequently mentioned *family*, *close friends* and *colleagues* as well as *doctors* or themselves. Some people tended to rely on others' support, whereas some others seemed to be not influenced by anyone.

A small set of questions addressed the *ability and motivation to process information*, elements that were borrowed from the Elaboration Likelihood Model (ELM), developed by Petty and Cacioppo (1981, 1984). Participants were asked to define how frequently they checked their e-mails during the day. They were also asked if they subscribed to any e-mail services and if they read them (e.g., newsletters, periodic information, etc.). Another question addressed the presence of possible elements of distraction (e.g., presence of others in the office or room, being exposed to frequent interruptions, being working in a noisy or quiet environment), which, according to the authors of the ELM, could influence the way people process information. Participants were also asked to provide an estimate of the number of e-mails received per day. The final question of the formative research survey was on the credibility and trustworthiness of sources of healthy lifestyle information. People were asked to state whether they trusted the Internet, their physician, friends or family members, a specific website (and indicated one), or information from one or more magazines, and whose advice they were most likely to follow.

Analyses revealed that employees regularly checked their e-mails several times a day and throughout the day (90.5%), using predominantly their work e-mail services. Moreover, people received a large number of e-mails during the day: 48% reported receiving more than 21 emails per day and 38% between 7 and 20 emails per day. Regarding the environmental distracting factors, many people said that they worked in a noisy and distracting environment, with other people in the room. Similar to the results about the most important people who influenced their behaviour, participants indicated the family doctor, friend or family, and official sources of health information (e.g., NHS, medical journals) as people who they trusted mostly and whose advice they were most likely to follow.

These results guided the content production of the intervention, including the number of e-mails as well as the timing of SMS text messages. According to formative research, the majority of participants reported checking their e-mails throughout the day, but indicated Monday mornings as moments where the inbound traffic of e-mails was heavy. Hence, the e-mails were scheduled to be delivered at 11pm on Wednesdays, to reduce the likelihood that the messages got lost or archived before being read. Text messages served as cue to action and reinforcement of the e-mail messages. Thus, they were sent at 11am on Fridays to help people prepare for the weekend and at 2:30pm on Mondays to set for the upcoming week.

3.2.2 Content development

Following the indications of Maibach and Parrott's (1995) seminal book *Designing health messages* and considering the feedback of formative research, a set of 12 thematic e-mails was developed. Modelled on Plotnikoff et al (2005) intervention, the MoveM8 intervention lasted 12 weeks. The e-mails aimed at motivating participants to engage in regular physical activity and meet the recommendations of the *Guidelines for healthy adults under age 65*, developed by the American Heart Association and American College of Sports Medicine (Haskell et al., 2007). Each message was designed to address one of the most salient beliefs and barriers, related to the core constructs of the Theory of Planned Behaviour (attitudes, subjective norms, perceived behavioural control, behavioural intention, and actual behaviour). Formative research revealed that the most salient factors that influenced negatively physical activity were related to perceived behavioural control and intention constructs and to control beliefs (e.g., perception of lack of motivation, lack of time, busy lifestyle). Consequently, the e-mail messages were weighted on these factors. Initially, the research team created a set of 15 e-mail messages related to the theory constructs, and these were validated using a Delphi technique (see below).

3.2.3 Content validation: a Delphi approach

The content of the theory-based e-mail messages was validated using a Delphi technique, which involved a panel of experts in physical activity and TPB intervention design, health behaviour change, physical activity promotion, health communication, and relevant experience with similar interventions. Experts were asked to evaluate the relevance and appropriateness of each message to the theoretical constructs. A multistage web-based Delphi approach was used (Brown, 2007; Colton & Hatcher, 2004; Hatcher & Colton, 2007). The selection of an expert panel was based on purposive sampling (Hasson, Keeney, & McKenna, 2000).

Ten experts were invited to participate in the expert panel, following the recommendations of the literature on the Delphi method (Colton & Hatcher, 2004;

Hatcher & Colton, 2007; Verhagen et al., 1998). Of the ten invited experts, six participated in the Delphi study. As previously stated, a set of 15 draft e-mail messages were posted in an online survey where members of the expert panel were given a unique login and asked to rate and comment on how well the message addressed each TPB construct. There were three messages for each TPB construct and for physical activity behaviour. Participants in the Delphi panel rated each message using a scale from 1 to 5, with 1 being not at all matched the construct and 5 being matched it completely. The panel members were also encouraged to comment on each message and offer suggestions for improvements. Upon completion of the first round, messages were improved and sent back to the panel for another review. After this second round, the experts achieved consensus on the content. Since the duration of the intervention was set to 12 weeks, as in Plotnikoff et al.'s (2005) study, the final set of e-mail messages was 12. Those messages that achieved the highest ratings and more positive comments during the Delphi exercise were retained for being used in the intervention.

3.2.4 Final set of messages

The final set of messages included three for intention and for perceived behavioural control, two for attitudes, two for subjective norms, and two for physical activity behaviour. More messages were dedicated to intention and perceived behavioural control because these were the most salient themes emerged in the formative evaluation phase. Similarly to Plotnikoff and colleagues (2005), physical activity messages focused on a specific weekly theme (e.g., goal-setting, overcoming barriers, planning physical activity, motivation, etc.). These themes were referred to also in the content of the SMS text messages, as they were designed to reinforce the TPB constructs.

The final set of e-mail messages was then tested for readability and adapted for HTML-formatted e-mails. Regarding readability, on average, messages were 516 words long, with a 6.1 mean score for the Flesch-Kinkaid readability test (associated with 71.5% Flesch reading ease value).

Table 3.1. MoveM8 programme final set of e-mail themes and associated TPB constructs

Week	TPB construct	Title (theme of the week)
1	Behaviour	Physical Activity: How much do I need?
2	Intention	Smart Goals
3	Attitudes	The best medicine
4	Perceived behavioural control	If it was just that easy
5	Subjective norms	It's hip to be active
6	Intention	Making a commitment
7	Behaviour	What is physical activity anyway?
8	Perceived behavioural control	The ups and downs of motivation
9	Attitudes	Weighing in on weight management
10	Intention	Plan it
11	Perceived behavioural control	You've got the power
12	Subjective norms	It's better together

The content of the e-mail messages was positively framed (attribute framing) and gain-framed (goal framing), since some authors generally reported that messages of this type are more likely to be accepted and hence are more effectively received than those based on a loss-frame (Daniel & Jensen, 2007; Rothman, Bartels, Wlaschin, & Salovey, 2006; Rothman, Martino, Bedell, Detweiler, & Salovey, 1999)[10]. Considering that the dimensions of goal framing and attribute framing were not outcomes of the MoveM8 intervention, the content was considered as 'invariant' or 'constant' between and within groups. It was then assumed that differences of content perception might not have influenced the outcomes of the intervention.

This assumption was also supported by a recent Cochrane review by Akl and colleagues (2011), who reported that both attribute and goal framing may have little effect on health consumers' behaviour. In particular, the authors found that participants of one reviewed study testing attribute framing understood messages better when they were negatively framed than when they were positively framed. Even if positively-framed messages produced a more positive perception of effectiveness than negatively-framed messages, there was little or no difference in persuasiveness in the context of

[10] Attribute framing is the positive versus negative description of a specific attribute of a single item or a state, whereas goal framing is the description of the consequences of performing or not performing an act as a gain versus a loss (Akl et al., 2011, p. 4).

attribute framing. Also in the context of goal framing, Akl and colleagues found that loss messages led to a more positive perception of effectiveness compared to gain messages and may also have been more persuasive (Akl et al., 2011). Little is known about the effects of these types of framing on understanding of the messages.

Having considered the evidence supporting the effectiveness of goal-setting strategies in workplace physical activity promotion interventions (Abraham & Graham-Rowe, 2009; Dugdill et al., 2008), and more in general as theoretical approach for behaviour change (Locke & Latham, 2006; Strecher et al., 1995), some messages invited employees to set 'SMART' goals[11] and put physical activity in their agenda. Moreover, to make the e-mail messages appear as more relevant to the eyes of employees, they were personalised, so they displayed the participant's name, and standardised, meaning that the content was the same for everyone. The greeting was followed by an introductory paragraph, explaining the theme of the week, a body with healthy tips and examples of physical activity, and a conclusion. To reinforce the weekly theme a healthy tip, a testimonial, or a quote were added to the e-mail body (see e-mail samples in Annex C). E-mails were sent each Wednesday morning at 11 am using an e-mail marketing application (iContact.com), which was used to schedule and automatically send the messages to all participants every week. Messages were sent in HTML format as well as in text only version in order to improve the readability from any e-mail client.

3.2.5 Text messages

SMS text messages were designed as prompts or reminders to reinforce the e-mail messages and followed the weekly theme structure. Each week two SMS reminders were sent, for a total of 24 text messages. They were under 160 characters in length, action oriented and personalised. A few samples of SMS texts are provided in the table below:

[11] "SMART" stands for Specific, Measurable, Attainable, Realistic, and Time specific.

Table 3.2. Sample of SMS text messages and weekly themes

Theme	Message	TPB Construct
How Much do I need?	Hi M8! The weekend is almost here. Y don't you plan for an activity you like doing? Just be sure to do it for at least 20-30 minutes. Get movin' M8!	Behaviour
Smart Goals	Hi M8! Have u set a SMART goal for the week? SMART goals are Specific, Measurable, Attainable, Realistic, Time specific. Be SMART, start w/ small steps!	Behavioural intention
If it was just that easy	Hello, M8! How did u do over the weekend? Learn from what went well and what did not. Set yourself up for success this week.	Perceived behavioural control

SMS needed to be short because text messages have a character limit of 160. However, since MoveM8 text messages were personalised, the participant's name also reduced the character limit of the message. On average, the length of the SMS text messages was 145 characters. After having tested a few services, the SMS Text Online service provided by TextAnywhere (www.textanywhere.net) was selected for use in this study. The Text Online service allowed scheduling in advance the sending of messages at specified times. Messages were sent each Friday at 11am with tips about including physical activity over the weekend and on Mondays at 2pm to encourage physical activity from the start of the week.

3.2.6 TPB survey development and pre-test

As recommended by the literature regarding TPB survey development (Ajzen, 2006a), elicitation interviews were used to identify the most relevant behavioural, normative and control beliefs, which were used in the TPB section of the survey. The most relevant behavioural beliefs (and associated benefits of physical activity) that were identified were: "having a healthy heart", "reducing stress", "feeling better", "better managing my weight", and "increasing concentration". The most significant influential people (and associated normative beliefs) were family, friends, doctor and co-workers. The most relevant difficulties associated with control beliefs were: having a work schedule, family obligations and social obligations placing high demands and having low motivation to engage in physical activity.

The survey was finally pilot-tested with another convenience sample of 17 employees. Internal consistency tests were used with the direct measures of the TPB constructs (see paragraph 3.3.1.3 for detailed information about the measures). All TPB constructs were measured with 7-point scales and 4 items for behavioural intention, attitudes, perceived behavioural control and 3 items for subjective norms, yielding a total of 15 items. Overall all scales showed acceptable Chronbach's alpha coefficients (.88 for behavioural intention, .77 for attitude, .70 for subjective norms, and .63 for perceived behavioural control). However, it was decided to drop items with corrected item-total correlations (CITC) lower than .50 and if this improved internal consistency of the scale (Ajzen, 2006a; DeVellis, 2003; Francis et al., 2004; Pallant, 2010). One item was dropped from each direct measure of attitude, perceived behavioural control and behavioural intention, yielding a final total number of 12 direct measure items, three direct measures per each construct. The final set of items was finally inserted in the web-based tool used for collecting the data.

3.2.7 MoveM8 branding and promotion strategy

Considering the growing evidence on the role of public health branding (e.g., Evans, Blitstein, Hersey, Renaud, & Yaroch, 2008; Evans & Hastings, 2008) and the success obtained by campaigns that used a strong and coherent visual image, see for example the aforementioned VERB™ campaign's branding strategy (e.g., Asbury, Wong, Price, & Nolin, 2008; Robert, 2007), a brand identity was developed for the MoveM8 programme. The brand identity included a logo, a defined colour-code and selected imagery were utilised on all materials, including correspondence, print advertisements (posters), leaflets, letterheads, post-it notes, on-line survey templates, project website and e-mails which were used before, during and after the intervention. Samples of the logo and the branded communication materials are shown in Figure 3.2 and 3.3.

Figure 3.2. The MoveM8 logo

Figure 3.3 The MoveM8 brand identity

3.3 Assessments

3.3.1 Surveys

In line with the objectives of this dissertation, the primary outcome measures were changes in the Theory of Planned Behaviour core constructs (attitudes, subjective norms, perceived behavioural control and behavioural intention) and physical activity behaviour. It is important to note that physical activity behaviour is considered a construct within the Theory of Planned Behaviour; given the important focus on changing behaviour, it is considered a primary outcome on its own.

Outcome measures were assessed through a series of three surveys: 1) a baseline pre-intervention survey (Time 0), collected one week before the intervention started; 2) a post-test survey three months after baseline (Time 1); and 3) a follow-up survey four months after the baseline assessment (Time 2). The schedule of the assessments is schematically represented in Table 3.3. All data were collected using a web-based survey platform (DimensionNet version 5.5, provided by SPSS, with mrInterview Professional version 5.5). Since the study involved the use of e-mails, employees were invited by e-mail to complete the study assessments online. All participants received a unique identifier that allowed them to access the survey when they wanted and save the progress before submitting it.

The baseline assessment measured demographics, physical activity behaviour, and TPB constructs. On average, the baseline survey took 20 minutes to be completed. Time 1 and Time 2 assessments measured physical activity behaviour and TPB constructs. Follow up surveys at Time 1 and Time 2 were completed in 15 minutes on average.

Table 3.3. Schedule of the assessments

Measures	Baseline	Time 1	Time 2
Demographics and background characteristics	X		
PA behaviour (IPAQ-L)	X	X	X
TPB constructs	X	X	X

3.3.1.1 Demographics and background characteristics

Background characteristics of the sample included demographics data, such as age (calculated through the difference between the date of enrolment and date of birth), gender, level of education (i.e., degree/degree level qualification including higher degree, A-level or equivalent, other professional qualification, O-Level passes/GCSE level passes or equivalent, no qualifications or other).

Additional background data included: hours worked per week (with the following categories: 1-10, 11-20, 21-30, 31-40, 41+); self-rated health status (excellent, very good, good, fair, poor); self-reported anamnesis of health conditions (i.e., allergies, arthritis, asthma, back problems, cancer, chronic bronchitis/emphysema, chronic pain, depression, diabetes, heart problems, heartburn or acid reflux, high blood pressure/ hypertension, high cholesterol, menopause, migraine headaches, obesity, osteoporosis, stroke); self-reported anamnesis of family history of chronic health conditions (high blood pressure, heart problems, diabetes, cancer, high cholesterol, asthma, obesity); family type: (single with no kids, single with kids, couple with no kids, and couple with kids); height and weight. These were collected in order to calculate the Body Mass Index (BMI), based on the formula: BMI = kg/m^2 (WHO, 2011g).

3.3.1.2 Physical activity

Physical activity was assessed using the long version of the International Physical Activity Questionnaire (IPAQ-L). The IPAQ-L was chosen because of its reliability, validity and its applicability to various contexts and countries worldwide (Bauman, Bull, et al., 2009; Boon et al., 2010; Craig et al., 2003; Guthold et al., 2008; Hallal et al., 2010; Jurakić, Pedišić, & Andrijašević, 2009). As it was mentioned in paragraph 2.1.2, in some studies reported positive findings about IPAQ's construct and concurrent validity against fitness (Fogelholm et al., 2006), and against general physical activity in various domains (Hagströmer et al., 2006).

The IPAQ-L was chosen because it allows recording of physical activity frequency and intensity, as it accounts for daily life activities and exercise carried out in four domains: leisure-time (LTPA), work (WPA), domestic and garden (DGPA), and active transportation (ATPA). Participants were asked to estimate the number of days they performed these activities (frequency) and the time (duration) spent doing these activities in the week before the assessment (i.e., last seven days recall). According to the Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire, total time spent in each type of physical activity for each sub-domain and overall total time was obtained by multiplying the number of days spent in each activity by the number of minutes per day (IPAQ Research Committee, 2005).

Table 3.4 Activity types and MET weighing factors for the four IPAQ-L domains

IPAQ physical activity domains	Activity type	Nr. of items (days × time spent)	Weighing factor (MET)
Work			
Vigorous (A)	Vigorous	2	8.0
Moderate (B)	Moderate	2	4.0
Walking (C)	Walking	2	3.3
Active transportation			
Cycling (D)	Moderate	2	6.0
Walking (E)	Walking	2	3.3
Domestic & Garden			
Vigorous in garden (F)	Moderate	2	5.5
Moderate in garden (G)	Moderate	2	4.0
Moderate in house (H)	Moderate	2	3.0
Leisure time			
Walking (I)	Walking	2	3.3
Vigorous (L)	Vigorous	2	8.0
Moderate (M)	Moderate	2	4.0

Notes: MET stands for metabolic equivalent: 1 MET equals the energy expenditure of sitting down quietly, 3.5 ml O^2/kg/min.

Intensity, expressed in MET-minutes/week or MET-hours/week, was calculated by weighting the amount of time spent in each physical activity with its respective metabolic equivalents. For example, in the job-related physical activity domain (WPA) and leisure-time physical activity domain (LTPA), the weighing factors are 8.0 for vigorous activities, 4.0 for moderate and 3.3 for walking. The weighing factors used for the variables in all IPAQ-L domains are presented in Table 3.4 above. The selected MET values were derived from the IPAQ Reliability Study (Craig et al., 2003) and an average MET score was derived for each type of activity using the compendium of Ainsworth et al. (2000; 2011): 1 MET equals the energy expenditure of sitting down quietly, 3.5 ml O^2/kg/min.

3.3.1.3 Theory of Planned Behaviour constructs

According to the model presented in Chapter Two, each predictor variable of the TPB model (attitudes, perceived behavioural control, subjective norms, and intention) can be measured directly and indirectly (Francis et al., 2004, p. 9). For example, direct measures can be assessed by asking respondents how positively or negatively they perceive the behaviour at stake (attitude), if they perceive any social pressure in engaging in that behaviour (social norms), if they have control on the behaviour at stake (perceived behavioural control), and if and to what extent they intend to perform that behaviour (intention). Attitudes, subjective norms and perceived behavioural control can also be measured indirectly by asking respondents to express their opinion about specific beliefs that represent the antecedents of attitudes, subjective norms and perceived behavioural control. The TPB literature about survey development (Ajzen, 2006a; Francis et al., 2004; Sutton et al., 2003) recommends collecting both direct and indirect measures as they can provide additional and more precise information about the cognitive elements underlying the behaviour under analysis. In this case, the specific behavioural focus was “to get at least 30 minutes of moderate physical activity on at least 5 days or 20 minutes of vigorous physical activity on at least 3 days this coming week”. These corresponded to the recommended levels of physical activity, according to the *Guidelines for healthy adults under age 65* (Haskell et al., 2007).

The TPB section of the survey contained a set of both direct and indirect measure items, for a total of 38 items (12 direct and 26 indirect items). Because this dissertation is focused on evaluating the impact of the intervention and on the understanding of the predictors of behavioural intention and actual behaviour, only direct measures were used.

The use of direct measures allowed creating and managing simpler and more parsimonious SEM models, hence reducing the risk of misspecification and non-identification, which is connected with the use of complex designs, as it will be explained below.

Direct TPB items assessed attitudes, subjective norms, perceived behavioural control and behavioural intention related to the performance of the behaviour in the coming week (future behaviour). All items were measured with 7-point scales. Summary or composite scores were computed following the indications of the literature (Ajzen, 2006a; Francis et al., 2004) and when reliability and internal consistency analyses allowed. The structural equation models utilised TPB latent factors measured through direct item indicators aimed at assessing the core constructs, similarly to other TPB-based studies which involved SEM analyses (e.g., Fen & Sabaruddin, 2009; Hagger et al., 2001; Lippke, Nigg, & Maddock, 2007; Plotnikoff, Lubans, et al., 2011; Plotnikoff et al., 2012). Even though some authors suggest treating Likert-time scales as ordinal (e.g., Elosua, 2011; Flora & Curran, 2004; Muthén & Asparouhov, 2002; Muthén & Kaplan, 1985), in this dissertation multivariate tests were performed treating these variables as if they were continuous, because “the power and flexibility gained from these methods outweigh the small biases that they may entail” (Johnson & Creech, 1983, p. 512). Reliability analyses (internal consistency and test-retest reliability) were computed for all direct measures as well as more advanced reliability tests involving a confirmatory factor analysis approach further described.

Attitude

Direct measures of attitude were assessed through three items (ATT1, ATT2, and ATT3) on 7-point bipolar scales based on the following couples of adjectives: “unimportant/important” (ATT1), “not enjoyable/enjoyable” (ATT2), and “exhausting/energising” (ATT3). An example of a direct measure of attitude question is: “For me, to get at least 30 minutes of moderate physical activity on at least 5 days or 20 minutes of vigorous physical activity on at least 3 days this coming week would be... (unimportant/important)”.

Perceived Behavioural Control

Direct measures of perceived behavioural control consisted of three items (PBC1, PBC2, and PBC3) and were measured through 7-point Likert-type scales (strongly disagree/strongly agree). Two items assessed self-efficacy or the confidence to perform the specific behaviour under question: "I am confident that I can get at least 30 minutes of moderate physical activity on at least 5 days or 20 minutes of vigorous physical activity on at least 3 days this coming week" (PBC1); "For me to get at least 30 minutes of moderate physical activity on at least 5 days or 20 minutes of vigorous physical activity on at least 3 days this coming week would be very difficult/very easy" (PBC2). One item assessed the controllability of the behaviour: "The decision to get at least 30 minutes of moderate physical activity on at least 5 days or 20 minutes of vigorous physical activity on at least 3 days this coming week is beyond my control" (PBC3) and was reverse coded before the analyses.

Subjective norms

Direct measures of subjective norms (injunctive norms) included three items (SN1, SN2 and SN3) assessing the opinions of important people in general. One item was measured using a 7-poing bipolar scale (with extremes I should not/ I should): "Most people who are important to me think that… I should not/I should… get at least 30 minutes of moderate physical activity on at least 5 days or 20 minutes of vigorous physical activity on at least 3 days this coming week" (SN1). The other two items were measured through a 7-point Likert-type scale (strongly disagree/strongly agree) and participants had to rate their agreement with the following statements: "It is expected of me that I get at least 30 minutes of moderate physical activity on at least 5 days or 20 minutes of vigorous physical activity on at least 3 days this coming week" (SN2); and "I feel under social pressure to get at least 30 minutes of moderate physical activity on at least 5 days or 20 minutes of vigorous physical activity on at least 3 days this coming week" (SN3).

Behavioural intention

Behavioural intention was measured using a generalised intention method, which is the most commonly used in TPB literature (Francis et al., 2004). The method involves the collection of information about the intention to perform a specific behaviour using at least three items. Behavioural intention was assessed through three items (INT1, INT2, and INT3) on a 7-point Likert-type scale ("completely disagree/completely agree"): "I want to get at least 30 minutes of moderate physical activity on at least 5 days or 20 minutes of vigorous physical activity on at least 3 days this coming week" (INT1); "I intend to get at least 30 minutes of moderate physical activity on at least 5 days or 20 minutes of vigorous physical activity on at least 3 days this coming week" (INT2); "I plan to get at least 30 minutes of moderate physical activity on at least 5 days or 20 minutes of vigorous physical activity on at least 3 days this coming week" (INT3).

3.1.1 Interviews

Semi-structured individual interviews and focus group interviews were conducted with employees who successfully enrolled in the MoveM8 programme and with employees who did not complete the enrolment. Interviews and focus groups followed an outline (provided in Annex B). First, the interviewer introduced the objective of the interview and explained his role. To refresh the memory of the interviewees, the interviewer showed a sample of MoveM8 branded material. The interviews were opened by asking interviewees to briefly introduce themselves and describe their type of job. After introductions and some ice-breaking questions, about past experience with health promotion programmes and physical activity, the interviewees were asked about their reasons for participation or not participation in the MoveM8 programme.

The decision to conduct qualitative interviews depended also on the fact that the declining survey response rates, obtained during the MoveM8 programme, suggested that the target population was hard to reach using survey-based techniques (both on-line and paper and pencil). Hence, qualitative techniques were considered an appropriate solution to answer the research questions and approach the target population.

Individual and group interviews are different qualitative approaches, are based on different assumptions and both have strengths and weaknesses. For instance, individual interviews are more efficient that focus groups and interviewers are typically able to cover more ground interviewing one person versus a group (Krueger & Casey, 2000). Individual interviews can have the disadvantage of creating anxiety in the respondent (Robinson, 1993), whereas group interviews have the advantage of reducing the individual perceived peer pressure and anxiety, by providing a more comfortable setting for discussion than individual face-to-face interviews (Greenbaum, 1998). Nevertheless, the presence of others might also bring the risk that the overall sense of responsibility and involvement may is shared among group members, resulting in less information and superficial responses, which can be overcome in individual interviews (Robinson, 1993). Additionally, group interviews usually elicit more information, which derive from the interaction and discussion time (Lunt, 1996; McQuarrie & McIntyre, 1990), whereas individual interviews evoke more individual focused information (McQuarrie & McIntyre, 1990).

In this study, the choice between individual interviews and focus groups depended on some logistic and feasibility considerations. For instance, MoveM8 participants were spread across 19 sites, which were located in different areas of the United Kingdom. Second, the characteristics and location of certain sites, campuses, departments and institutes (for example, the University of Nottingham, De Montfort University or 3M), would have made it even more difficult to gather people coming from different areas in a unique location. Therefore, for big organisations, individual interviews were considered an optimal solution, as they could be “conveniently scheduled to meet the time constraints of both interviewer and informant” (Murphy & Dingwall, 2003, p. 80). For smaller organisations, with no more than 10 employees each, a natural group interview was deemed more appropriate (Green & Thorogood, 2004). Therefore, the approaches varied depending on the size of the organization and on the number of participants.

3.4 Participants and procedures

3.4.1 Intervention recruitment strategy

As a widely diffused practice in workplace health promotion programmes and in e-health interventions (Thompson et al., 2006) and as implemented in similar studies (Franklin, Ploutz-Snyder, et al., 2006; Plotnikoff et al., 2005; Simpson et al., 2000), a two-step recruitment strategy for promoting the intervention among employees and for identifying interview participants was followed. This strategy is based first on an institutional and then on an individual enrolment. Simpson and colleagues (2000) in their National Workplace Health Project, and Plotnikoff et al. (2005) first identified a liaison person in the organization that helped recruiting participants. Franklin et al. (2006) contacted all HR leaders and CEOs of selected companies, who were also used to serve as liaison to the study team for further contacts. These people were asked to send e-mail invitations to all the staff. Ideally, this direct contact with employees would have served as active recruitment strategy, which is considered to be effective in engaging potential participants and encourage them to enrol (Linnan et al., 2002; Linnan, Sorensen, Colditz, Klar, & Emmons, 2001). This is because the endorsement by a credible person in a social network within the organisation could have resulted in larger changes of individual enrolment, as “individuals may volunteer out of a desire to please the respected individual, to receive social approval, and/or because valued others (e.g., friends) enrol, rather than because of a true desire to participate in the programme” (Thompson et al., 2006, p. 435). Moreover, as seen in Chapter Two, managerial support is associated with higher participation rates and is recommended in the literature (DeJoy et al., 2009; Fielding, 1984; Harden et al., 1999; Marshall, 2004; Sherman, 2002).

To provide the employees with more chances to enrolling in the MoveM8 programme, a flexible recruitment was implemented, allowing for six enrolment periods (or waves) from September 2009 to April 2010. This strategy was sought to maximise participation, as suggested in some studies promoting physical activity (e.g., Chinn et al., 2006; Prinz et al., 2001; Serxner, Anderson, & Gold, 2004).

3.4.1.1 Institutional enrolment

Organisations were recruited from direct contact with CEOs, Occupational Health Managers, Human Resources Officers, Health and Safety Managers and Health Advocates, at individual workplaces. Word-of-mouth, personal contacts, and 'cold call' e-mails were used to promote the study. With the help of one of the research team members, a workplace health improvement specialists, the MoveM8 advertisements were sent to 250 organizations, with a focus on larger companies (of more than 250 employees). Other potential organisations were identified by a web-search of UK-based organizations with corporate social responsibility (CSR) functions and Health Promotion initiatives listed on their websites and these were contacted by e-mail.

The promotional efforts were aimed at recruiting organisations based especially in the North East region and in the East Midlands. The North East is considered one of the poorest and most deprived areas in the north of England compared to the south in terms of health and life expectancy. According to the 2009 Health Profile of England "in all northern regions, as well as both the East and West Midlands, life expectancy is significantly shorter than in the regions to the south. For both sexes, those living in the North East or North West live approximately two years less than those in the South East or South West. […] There are inequalities in the determinants of health across England; for example, approximately 34% of people living in the North East live in the most deprived fifth of neighbourhoods in England, 10.6% of adults being classified as physically active" (DH, 2010a, p. 12).

Invitation e-mails were sent to organisation contact persons and provided an overview of the study and with a brief explanation of what it involved for the organisation. The letters informed organizations that all recruitment materials would have been provided to them, including MoveM8 branded posters, emails, banners for their intranet sites, and post-it notes that could be placed on computer monitors, in bathrooms and in other common areas of the worksite, as per ethical regulations. Organizations had to go online to enrol and complete an enrolment form or send an e-mail request to the research team. Once this was completed, the worksite was "enrolled" and added to the list of participating worksites. This allowed employees at each organization to subsequently enrol in the program.

Organisations successfully enrolled in the MoveM8 programme by submitting either a print support-letter or an online form, in which they agreed to participate in the programme. Upon receipt of the enrolment documents, the research team mailed them a promotional package, containing branded promotional materials. These materials were disseminated to employees and posted in common areas of the workplaces, with the help of local organizations' health advisers, safety and health managers.

3.4.1.2 Individual enrolment

Interested employees had to enrol in the study on the project website. Potential participants were presented with the study information sheet and a statement of informed consent online. Upon submitting their informed consent, they had to complete a brief eligibility questionnaire.

Eligibility criteria. To participate in the study individuals had to be at least 18 years old and employed at one of the participating worksites. They had to provide a valid e-mail address, a mobile phone number, and had to agree to participate in the 12-week intervention, including the completion of baseline and follow-up assessments in English. Participants were excluded from the study if they did not meet the inclusion criteria and if they did not agree to the informed consent or those who reported any physical impairment that prohibited them from meeting physical activity recommendations or that required medical supervision. If they were eligible, participants were directed to the online baseline assessment. Once they completed the baseline assessment, participants were considered 'successfully enrolled' in the study.

3.4.2 Interviews and focus groups recruitment strategy

Two were the target populations of the interviews and focus groups: 1) *enrolled employees*, defined as employees who successfully enrolled in the MoveM8 intervention by submitting the informed consent, matching the eligibility criteria, completing the baseline assessment, and not actively dropping out; 2) *non-enrolled employees*, defined as employees who submitted the informed consent, matched the eligibility criteria, started the enrolment process but did not complete the baseline assessment, and therefore were not considered enrolled in the MoveM8 programme. The number of potential interview participants, including enrolled and non-enrolled employees is provided in Table 3.5.

Table 3.5. Number of potential interview participants (including employees who enrolled and did not enrol in the MoveM8 programme)

	Enrolled employees		Non-enrolled employees	
Enrolled organisations	*n*	%	*n*	%
University of Nottingham	207	56.6	30	33.7
De Montfort University	66	18	35	39.3
Stockton Riverside College	28	7.7	2	2.2
Tameside MBC	17	4.6	10	11.2
3M	14	3.8	2	2.2
Fujifilm DioSynth	12	3.3	0	0
Equity Direct Broking Ltd.	4	1.1	6	6.7
Leeds Metropolitan University	3	.8	0	0
Astbury Digital	2	.5	0	0
Zest People Ltd.	2	.5	0	0
HMP Holme House	3	.8	1	1.1
Vopak Terminal Teesside	2	.5	2	2.2
Two Trees Tameside Sports College	2	.5	0	0
Cummins	1	.3	0	0
Dow Chemical Company Ltd.	1	.3	0	0
Redcar & Cleveland Borough Council	1	.3	0	0
Vodafone Group Services Ltd.	1	.3	1	1.1
Total	366	100	89	100

To identify and recruit potential participants for the interviews and focus groups, purposive sampling techniques were used. Purposive sampling is the most commonly used technique for sampling in qualitative studies (Guest, Bunce, & Johnson, 2006; Higginbottom, 2004) and is also known as judgmental sampling (Marshall, 1996), which means that participants are selected on the basis of specific characteristics or criteria. Different sampling techniques were used depending on the type and size of the organisation, on the number of employees enrolled in the MoveM8 intervention, and on practicality and logistic considerations (Miles & Huberman, 1994; Tuckett, 2004). For enrolled employees coming from large organizations with a high number of enrolled employees (e.g., University of Nottingham, De Montfort University, Stockton Riverside College and Tameside Metropolitan Borough Council), potential interview participants were identified using a stratified random purposeful sampling (Miles & Huberman, 1994; Onwuegbuzie & Leech, 2007; Patton, 1990). This sampling technique consisted of a random selection of participants within a sub-population (e.g., enrolled employees), identified using a sampling frame which combined age and gender strata, as exemplified in Table 3.6. Stratified random purposeful sampling is appropriate "when potential purposeful sample is too large" (Miles & Huberman, 1994, p. 28). Stratification was conducted at gender and age levels, so that a proportional number of participants from each sub-population had equal chance to be invited to take part to the interviews.

Table 3.6. Example of stratification by gender and age for participants at the University of Nottingham

	Population of enrolled employees $N_{UNott} = 207$				Expected sample n = 30		
Stratum I Gender	*F*	*M*	*Tot*		*F*	*M*	*Tot*
Count	175	32	207	Count	25	5	30
%	85%	15%	100%	%	85%	15%	100%
Stratum II Age	*30- yrs.*				*30- yrs.*		
Count	61	12		Count	9	2	
%	35%	38%		%	35%	38%	
	31+ yrs.				*31+ yrs.*		
Count	114	20		Count	16	3	
%	65%	62%		%	65%	62%	
Tot	175	32		Tot	25	5	
%	100%	100%		%	100	100	

According to the stratified random purposeful sampling procedure, a random number was associated with each participant in each sub-category or strata (Onwuegbuzie & Leech, 2007). E-mail invitations were sent until the expected sub-sample size was reached. For example, at the University of Nottingham, from the total population of enrolled employees (n = 207), the expected sample consisted of 30 enrolled employees, proportionally represented by gender and age-group. Multiple sub-samples were drawn and participants were invited until theoretical saturation was reached.

For enrolled employees in small organisations and for non-enrolled employees, recruitment was conducted according to maximum variation and extreme case sampling. Maximum variation sampling, which is one of the most commonly used techniques in qualitative research (Sandelowski, 1995), consists in selecting a wide range of individuals, groups, or settings so that “all or most types of individuals, groups, or settings are selected for the inquiry” (Onwuegbuzie & Leech, 2007, p. 112). Extreme case sampling selects “an outlying case or one that possesses one or more extreme characteristics” (Onwuegbuzie & Leech, 2007, p. 113). Non-enrolled employees were considered “outlying cases”, because they presented the extreme characteristic of not being enrolled in the MoveM8 programme.

E-mail invitations were sent to all employees belonging to small organisations in order to achieve a maximum expected sample of 7-8 participants. E-mail invitations were sent to all non-enrolled employees, given the smaller number of potential participants, in order to increase the chances for getting a sufficiently large sample.

To provide even more flexibility to potential participants, if face-to-face meetings could not be organised, interviews were conducted via telephone or Skype. To increase the chance to recruit enough employees for the interviews, incentives were used in forms of individual gift vouchers (£10 for each participant) which were given upon completion of the interviews. All face-to-face interviews and focus groups were recorded with an MP3-recorder; Skype interviews were recorded with CallRecorder, an application available for Mac OSX.

3.5 Analysis

3.5.1 Statistical analysis and considerations

The analysis strategy for the first two objectives of this dissertation involved a preliminary examination of the main outcome variables (physical activity and TPB core constructs) and relevant demographic background variables, by analysing frequencies and distributions for categorical variables and descriptive statistics for continuous variables. Univariate and bivariate tests were conducted using IBM SPSS Statistics v.19.

After having evaluated the descriptive statistics of the population, the relationships among the TPB variables were modelled using structural equation modelling (SEM) techniques. Structural equation modelling (SEM) is a family of statistical techniques and procedures used for testing and estimating causal relationship between and among variables. Other terms that designate SEM techniques include covariance structure analysis, or covariance structure modelling or analysis of covariance structures (Kline, 2005). SEM techniques are often used in theory testing and model development in various research fields and applications, such as psychology (MacCallum & Austin, 2000), behavioural genetics, education, sports medicine, public health, and many more (Kline, 2005). These approaches usually combine exploratory and confirmatory factor analyses (Brown, 2006), used to estimate measurement models with observed and latent factors, with path analyses, which estimate a structural model, which allows to infer causal relationships between observed and unobserved variables. Confirmatory factor analysis (CFA) is a specific component often used to test measurement properties (i.e., scale reliability of a survey instrument and measurement of latent variables, high order factor analysis, etc.) and it is appropriate CFA is appropriate in theory testing, when an already established measurement instrument has been utilised (Brown, 2006; Kline, 2005).

As recommended in SEM literature (Brown, 2006; Byrne, 2009; Kline, 2005; Schumacker & Lomax, 2004), a two-step approach was used. The two-step approach consists of first analysing the measurement structure and then the structural relationships among variables. This approach is useful because it allows accounting for measurement error and isolating potential problems of model misspecification prior to testing any structural and causal relationships between variables.

The first step involved a test of a measurement model, in order to first identify and isolate potential problems in the measurement instrument (i.e., reliability, convergent and discriminant validity). The analyses of the TPB measurement model were initially conducted within each dataset separately (baseline and each follow-up) in order to determine whether the measurement properties were replicating at each point in time. Then the measurement model was tested against longitudinal measurement invariance and measurement invariance between groups (i.e., intervention groups). Measurement invariance involved the testing of various models by comparing a fully unconstrained baseline model with several nested models presenting more stringent constraints (i.e., factor loadings, intercepts, variances, etc.). Inter-correlations of variables were routinely examined and results were combined with those of confirmatory factor analyses (CFA), which resulted in decisions about combining indices or introducing latent constructs into the analysis before testing full structural models cross-sectionally and longitudinally. CFA provides a stronger analytic framework for construct validation than traditional methods, as it allows for more accurate estimates of convergent and discriminant validity, which are adjusted for measurement error (Brown, 2006, p. 3). Moreover, measurement invariance was tested in order to define to which extent the measurement model remained the same over three time points. The procedure will be further explained and described in the results section.

The second step involved the investigation of structural relationships between variables and consisted of the analysis of a series of full structural equation models, where causal paths were added between the TPB latent factors and behaviour, according to the original Theory of Planned Behaviour model, as presented in Chapter Two. The aforementioned two-step approach combines full information and limited information estimation strategies. Limited information estimation strategy uses path diagrams to identify the structural relationships of interest and to define the relevant linear equations. The overall model is divided into pieces and estimates of the coefficients are computed within each piece separately using statistical methods that are appropriate for that piece.

Full information estimation approaches can yield more efficient estimates and more precise statistics about goodness of model fit (Bollen & Long, 1993; Jaccard & Guilamo-Ramos, 2002) and is also appropriate when dealing with missing data (Arbuckle, 1996). However, the full information estimation approach can also expose a model to misspecification issues, hence the necessity to implement a two-step analysis strategy. By contrast, in limited information estimation, specification error is compartmentalized. Limited information estimation also allows one to tailor the analytic method to the nature of the variables involved in a given piece of the overall model and allows using specific regression types to predict the outcome variables (e.g., logistic regression, ordinal regression, OLS regression, Poisson regression). Full information estimation strategies will be pursued but, where necessary, limited information estimation approaches will be used.

Data were analysed using two software packages for SEM: AMOS v.19, which is available as IBM SPSS add-on (Arbuckle, 1994, 2010a, 2010b), and Mplus v.6.12, developed by Linda and Bengt Muthén (Muthén & Muthén, 2011). SEM computer programs, like AMOS or Mplus, use full information estimation approaches to estimate path coefficients and associated standard errors simultaneously in the context of a full system of linear equations implied by the model. The same statistical algorithm (e.g., full information maximum likelihood or robust maximum likelihood estimation) is applied throughout the analysis and these algorithms are appropriate strategies to deal with large amount of missing data and with violations of normality assumptions. In particular, Mplus is a good software tool for the analysis of cross-sectional and longitudinal data, single-level and multilevel data. As opposed to AMOS, Mplus has additional features that allow carrying out analyses for various types of observed variables. Different types of regressions are performed by the programme according to the type of observed data. For instance, for continuous outcome variables, linear regression models are used (Muthén & Muthén, 1998, pp. 1–3).

3.5.1.1 Factor structure of multiple item TPB measures

The theoretical structure of the full TPB model, which includes beliefs and predictors of behavioural intention, is complex and presents several limitations and challenges when it has to be examined in the context of structural equation modelling. The presence of a large number of parameters to be estimated and the need to justify the causal relationships between variables implied by the full TPB model increases the risk of misspecification and under-identification of the model, especially when the estimands outweigh the size of the sample (Kline, 2005). For example, in this case, a full TPB model with a latent factor mean structure would have involved ten belief item as indirect indicators of attitude, eight for subjective norms and perceived behavioural control; and 12 items assessing four latent factors (attitudes, subjective norms, PBC and behavioural intention). The total number of observed variables would be 38, including 38 factor loadings (or regression weights) and 38 residual variances, 38 item intercepts, four latent factor variances, and six covariances.

With 38 observed variables, the number of distinct values in a covariance matrix to be used in SEM calculations would be $p(p + 1)/2$, 38(38 + 1)/2 = 741 and the number of free parameters in a saturated model (i.e., a model with all parameters indicated) would be $p(p + 3)/2$, 38(38+3)/2 = 779. In general, a sufficient condition for any theoretical model to be identified, the number of free parameters to be estimated must be less than or equal to the number of distinct values in the matrix (Schumacker & Lomax, 2004, p. 65). So, if the sample is small relative to the number of variables, there is not enough information available to estimate the parameters in the saturated model. Moreover, a 20:1, or even a more realistic 10:1 ratio between observations and parameters was respected (Kline, 2005), to test such a complex model a sample of more than 7,000 people would have been needed.

Therefore, to guarantee and achieve a specified TPB model, it was decided to utilise only direct measures for the utilised core constructs. The use of direct measures in SEM modelling granted theoretical fidelity, as demonstrated in many other studies, which utilised SEM techniques to test the TPB model (e.g., Fen & Sabaruddin, 2009; Hagger &

Chatzisarantis, 2009; Hagger et al., 2001; Rhodes, Blanchard, & Matheson, 2006; Rhodes & Courneya, 2003b).

An example of the latent factor model used in this dissertation is shown in Figure 3.4. Ellipses represent latent variables (unobserved endogenous variables); straight lines indicate causal paths between variables. Double-headed arrows indicate correlations or covariances between variables. Arrows pointing toward Intention and Behaviour represent 'disturbance terms', which reflect the variance on a latent variable not explained by the other variables included in the model (unobserved exogenous variables). For clarity, the graphical representation of model below does not include item indicators of the latent factors (observed endogenous variables). The dashed arrow from PBC to behaviour indicates a possible direct effect of PBC on behaviour, as theorised and suggested by Ajzen (1985). The theorised TPB model including direct effect of PBC on behaviour was also tested cross-sectionally and will be discussed in the following chapters.

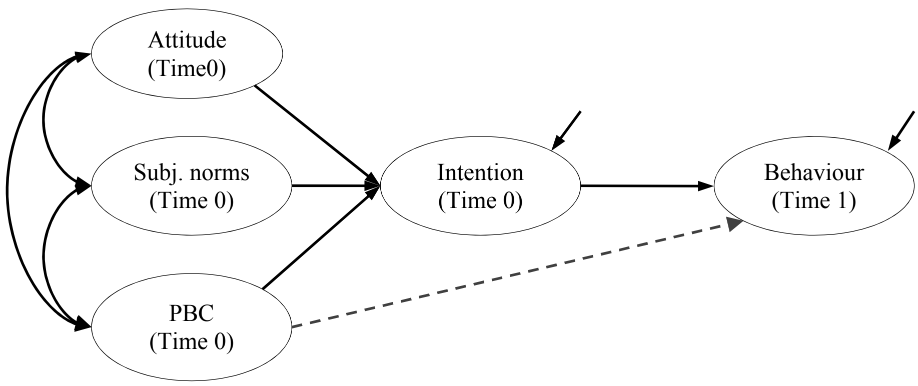

Figure 3.4. Structural model representing the TPB

3.5.1.2 Clustering

Since data were collected from employees coming from 17 different organizations, there was the possibility of clustering effects. These were evaluated by examining intra-class correlations. Models were adjusted for clustering either by introducing covariates reflecting organization units, or by using robust estimators available in Mplus if the data allowed.

3.5.1.3 Model fit criteria and evaluation

In structural equation modelling literature, there are many criteria to estimate the goodness of fit of a model. Even though there is no 'gold standard' modification index, methodological literature suggests including several measures of model fit (Bollen & Long, 1993), which can be grouped under three categories, such as measures of *absolute fit*, fit *adjusting for model parsimony* and *comparative* or incremental fit (Brown, 2006, p. 82). Absolute fit indices assess the fit of a model from an absolute level, so testing the hypothesis that the model covariance matrix fits the matrix of the population, without considering other aspects. Examples of absolute fit indices are the Chi-square test and the standardised root mean square residual (SRMR). Parsimony correction fit indices incorporate a correction for poor model parsimony, which is based on the number of freely estimated parameters as expressed by model degrees of freedom (Brown, 2006, p. 83). One of the most commonly used indices of this category is the root mean square error of approximation (RMSEA), developed by Steiger and Lind. The RMSEA is a population-based index that relies on the noncentral chi-square distribution, which is the distribution of the fitting function when the fit of the model is not perfect (*ibid.*). Comparative or incremental fit indices evaluate the fit of a user-specified solution in relation to a more restricted nested baseline model, the so called "null" or "independence" model, in which all covariances are constrained to zero (Brown, 2006, p. 84). Comparative fit indices include the Bentler CFI and the Tucker-Lewis index, also defined as the 'non-normed fit index'.

According to Kline (2005, p. 134 and ff.), global fit indices should include the traditional overall *chi-square test of model fit* (in AMOS it is labelled as CMIN), which should be non-significant (i.e., larger than .05). However, due to its limitations (i.e., with small sample size and non-normal data tends not to follow a normal chi-square distribution; and tends to be inflated by sample size (Brown, 2006, p. 81), it is recommended to inspect other indices when evaluating the model fit; the Steiger-Lind root mean square error of approximation (RMSEA), which should be less than .08 in order to state that the model fits well); the p value for the test of close fit (PCLOSE), which should be non-significant (i.e., larger than .05); the Bentler Comparative Fit Index (CFI), which should be larger than .95; and the standardised root mean square residual (SRMR), which should be less than .05.

Table 3.7. Model fit criteria

Global fit indices	Range	Criterion for fit
Absolute fit (descriptive)		
Chi Square with its p-level	Larger than 0	The smaller the better ($p \geq .05$)
SRMR	0 – 1.0	< .05
Chi Square /df	Larger than 0	$3.0 \geq x \geq 1.0$
Parsimony correction fit		
RMSEA	0 – 1.0	≤ .05 (good fit) ≤ .08 (moderate fit)
p-value for close fit	0 – 1.0	> .05
Comparative fit		
CFI	0 – 1.0	≥ .95
Additional criteria		
Modification indices	Any	≥ 10
Standardised residual covariances	Any	≥ 2.58

Together with global fit indices, more focused tests of fit were undertaken considering standardised residual covariances (which should range from -2.00 to 2.00), and modification indices larger than 10. Parameter estimates were also checked for Heywood cases (Brown, 2006; Kline, 2005), which may include “negative variance estimates or estimated correlations between a factor and an indicator with an absolute value greater than 1.0” (Kline, 2005, p. 114). Heywood cases can be caused by specification errors, model non-identification, presence of outlier cases, the combination of a small sample size and only two indicators per latent factor.

3.1.2 Qualitative analysis strategy

All interviews and focus groups were transcribed verbatim and coded according to a thematic framework, and presented in narrative summaries. The software used for the transcriptions was f4 (Windows) and f5 (for Mac OS), a free software produced by Dr. Dresing & Pehl GmbH, Marburg, Germany (audiotranskription.de). Data were analysed using the Software Atlas.ti v6.2.26.

Thematic analysis (Ritchie & Lewis, 2003) was used for analysing interviews and focus groups, in order to fulfil the third objective of this dissertation, which consisted in understanding the reasons *why* people enrolled in the MoveM8 programme. Since the aim of qualitative techniques is to investigate a phenomenon in its depth rather than in its breadth, it is usually followed a positivistic approach, which does not imply seeking generilsability or ecological validity (Marshall, 1996; Miles & Huberman, 1994). Framework and thematic analyses allow qualitative data to be analysed by combining a priori thematic classifications reflecting the study objectives and research questions, with ex post themes elicited during interviews (Murphy & Dingwall, 2003; Pope, Ziebland, & Mays, 2000; Ritchie & Lewis, 2003; Waller, Marlow, & Wardle, 2006). This technique combines deductive and inductive process in analysing qualitative data and was chosen because of the nature and focus of the research questions outlined by the third objective of this dissertation.

CHAPTER FOUR
RESULTS

CHAPTER OUTLINE

4.1 Intervention recruitment results

Enrolled organisations

During the recruitment period (September 2009 - April 2010), employers were contacted through the collaboration of workplace improvement specialist (S. L.), who stated that "about 25 employers in the Stockton area were contacted. Across the North East region, the MoveM8 advert went to over 100 employers. Nationally, it went to more than 100 companies with a focus on larger ones (with more than 250 employees). It was estimated that from 15 to 20 Workplace Health Improvement Specialists in the country were contacted as well". A total of 19 organisations submitted the participation letter and enrolled in the study. These estimates were based on the feedback provided by the workplace improvement specialist who was part of the MoveM8 research team and helped diffusing the MoveM8 advert across his contacts using personal communication. During the recruitment period, one organisation decided to withdraw after a few months and another did not recruit any employees. Eventually, 17 organisations provided at least one employee as participant (see Table 4.1).

Enrolled employees

During the recruitment period, a total of 469 employees passed the eligibility check and started the baseline survey. Over six recruitment waves, a total of 393 employees (about 74%) successfully completed the baseline assessment and were enrolled in the study. It was estimated that the overall population of employees consisted of more than 32,500 people, which corresponded to an average participation rate of 1.25% across the 17 workplaces. The total population estimates (included in Table 4.1) were based on data published on websites or online news venues, or were estimated on the basis of interviews with occupational health advisers and workplace health advocates, as the organisations did not provide the research team with this information.

Table 4.1. Organisations participating in the MoveM8 programme, and number of interested and enrolled employees

Organisations	Employees who started enrolment	Employees who enrolled	Estimated total population	Participation rate (%)
University of Nottingham	237	220	7100	3.10
De Montfort University	109	74	2700	2.74
Stockton Riverside College	33	31	400	7.75
Tameside MBC	27	17	9000	.19
3M	16	14	3250	.43
Avecia Biologics (Fujifilm DioSynth)	12	12	500*	2.40
Equity Direct Broking Ltd.	10	4	1100	.36
Leeds Metropolitan University	4	4	3000	.13
Astbury Digital	3	3	20**	15.00
Zest People Ltd.	3	3	4	75.00
HMP Holme House	4	3	550*	.55
Vopak Terminal Teesside	4	2	250*	.80
Two Trees Tameside Sports College	2	2	250**	.80
Cummins	1	1	700	.14
Dow Chemical Company Ltd.	1	1	200	.50
Redcar & Cleveland Borough Council	1	1	2000	.05
Vodafone Group Services Ltd.	2	1	1545	.06
Total	469	393	32569	1.21[a]

Notes: All estimates about the total population are based on official documents published on the Internet: University of Nottingham (UoN, 2011); De Montfort University (DMU, 2012); Stockton Riverside College (SRC, 2011); Tameside MBC (Washington, 2008); 3M (3M, 2012); Avecia Biologics/Fujifilm DioSynth (Occupational Health Adviser, personal communication, July 27, 2011); Equity Direct Broking Ltd. (Equity Insurance Group Ltd., 2012); Leeds Metropolitan University (LMU, n.d.); Zest People (Zest People Ltd., 2011); HMP Holme House (Occupational Health Adviser, personal communication, July 29, 2011); Vopak Terminal Teesside (Occupational Health Adviser, personal communication, July 23, 2011); Cummins (Cummins, 2011); Dow Chemical Company (McLauchlan, 2009); Redcar & Cleveland Borough Council (Redcar Cleveland Borough Council, 2012); Vodafone Group Services (WorkSmart.org.uk, 2011).
The estimates indicated by an asterisk (*) are based on personal communication with occupational health advisers; those labelled with two asterisks (**) are based on estimates according to the type of organisation and sector, as it was not possible to obtain the information from the Internet. ([a]) represents the average participation rate.

4.2 Sample characteristics

Participants of the MoveM8 intervention were the 393 employees who successfully enrolled during the recruitment period. They came from 17 different UK-based organisations (see Table 4.1). As participants were unevenly distributed in these clusters, to account for possible clustering effects, the 17 organisations were grouped into five clusters, which represented the type of organisation. One cluster included universities, such as Leeds Metropolitan, University of Nottingham and De Montfort University, Leicester. This cluster represented the majority of the sample, with 298 enrolled employees (75.8% of the full sample). A second cluster included two colleges: Stockton Riverside College and Two Trees Tameside Sports College, yielding a subsample of 33 employees (8.4%). A third cluster consisted of organisations working in the chemical industry and related industries in the Teesside area, with more than 250 employees, namely FujiFilm Dyosinth (formerly known as Avecia Biologics Ltd.), Dow Chemical Company Ltd., Vopak Terminal Teeside, Cummins, and 3M. This cluster had 30 employees (7.6% of the full sample). A fourth cluster included two borough councils, Redcar & Cleveland and Tameside Metropolitan, with 18 employees in total (4.6%). A fifth cluster represented service companies, small-to-medium enterprises (SMEs), and the remaining organisations with a small number of employees (Astbury Digital, Zest People Ltd., Vodafone Group Services and Equity Direct Broking Ltd., HMP Holme House), for a total of 14 participants (3.6% of the sample).

4.2.1 Socio-demographic and background characteristics

In Table 4.2 are summarized frequencies and percentages of the selected demographic and background characteristics of the sample. The majority of the sample was female (78.9%), and the mean age was 39.4 years (SD = 11.7, range = 18 – 63). To simplify comparisons with other variables, age was recoded into a categorical variable (age group): 21% of participants ranged between 18 and 27 years, 28% between 27 and 39, 27.5% between 40 and 49 years, and about 23% ranged between 50 and 63 years. A significant age difference was found among people working in different types of organisations: $F_{(4,\ 363)} = 2.767$, $p = .027$, eta squared (η^2) = .03. On average, people working in borough councils (M = 32.42, SD = 10.28) were significantly younger (about 10 years) than those working in chemical companies (M = 43.00, SD = 9.95). The mean age differences between the other groups and type of organisations were non-significant.

Family status. The majority of the sample included couples (68.7%), followed by singles (30.8%), and other (.5%). The 'other' category included those who reported living with parents or being widowed, hence it was recoded as 'single'. There was a significant difference in age among the various family statuses: $F_{(2,\ 365)} = 8.432$, $p < .001$, $\eta^2 = .04$. The mean age of singles (M = 35.50, SD = 12.64) was significantly higher than those of couples (M = 40.90, SD = 10.88).

Work status. The hours worked per week were used as proxy for type of job (full-time or part-time). Hours worked per week were initially classified in the following categories: 1-10, 11-20, 21-30, 31-40, and 41 or more. A categorical variable was created including three categories: 'Full-time (80% to 100%)', defined as working from 31 to more than 41 hours per week; 'Part-time (50% to 70%)', including those who reported working from 21 to 30 hours per week; and 'Part time (25%)', which included those who reported working less than 20 hours per week.

Education. The 70% of participating employees reported having obtained a higher degree qualification, 14% an advanced level (A-level) or equivalent, 9% other professional qualifications, 6.4% O-level passes or General Certificate of Secondary Education (GCSE), and .5% reported having obtained no qualifications (three employees). There were significant age differences among people reporting different education levels: $F_{(4,\ 7.68)} = 4.011$, $p = .047$, $\eta^2 = .01$. Post-hoc comparisons with Tukey's HSD revealed that the mean age of A-level participants (M = 35.47, SD = 12.77) was significantly different from that of those who obtained other professional qualifications (M = 43.29, SD = 9.03). And the mean age of those who obtained an O-level/GCSE certificate (M = 42.24, SD = 12.52) was significantly higher than those who obtained A-level certificates.

Table 4.2. Frequencies and percentages of selected background demographic characteristics

Categorical and dichotomous variables	n		%
Gender			
Female	310		78.9
Male	83		21.1
Age groups			
18 – 27 years	83		21.1
28 – 39 years	110		28.0
40 – 49 years	108		27.5
50 years or more	92		23.4
Education level			
Degree/degree level qualification (including higher degree)	275		70.0
A-level or equivalent	55		14.0
Other professional qualification	36		9.2
O-Level passes/GCSE level passes or equivalent	25		6.4
No qualifications	2		.5
Workplace type (cluster)			
Universities	298		75.8
Colleges	33		8.4
Service companies (SMEs)	14		3.6
Chemical companies	30		7.6
Borough councils	18		4.6
Work status			
Full time (80-100%)	332		84.5
Part-time (50-70%)	44		11.2
Part-time (25%)	17		4.3
Family status			
Single, with no kids	102		26.0
Single, with kids	21		5.3
Couple, with no kids	144		36.6
Couple, with kids	126		32.1
Perceived health status			
Excellent	17		4.3
Very Good	135		34.4
Good	189		48.1
Fair	49		12.5
Poor	3		.8
BMI classification			
Underweight	9		2.3
Normal range	178		45.3
Overweight	124		31.6
Obese	82		20.9
Continuous variables	M	SD	Range
Age (years)	39.27	11.68	18 - 63
BMI at baseline (kg/m^2) - winsorised	26.20	5.17	17.11 - 42.98

Notes: Age groups categorical variable derives from the continuous variable Age (years) and BMI classification is based on BMI at baseline (kg/m^2) continuous variable.

4.2.2 Health profile

To enrol in the study and per ethical requirements, employees had to be 'healthy volunteers', which means that they were not recruited through the NHS as NHS patients. One of the eligibility criteria was that participants should not have been affected by any physical impairments or long-term conditions that could have hindered their possibility to engage in regular physical activity. The overall health profile of the full sample at baseline showed indicators of good health conditions, as testified by three indicators: self-reported perceived health status, self-reported personal history and family history of chronic conditions, and body mass index (BMI), calculated on self-reported weight and height.

Perceived health status. Perceived health status scale ranged from poor to excellent and, as expected, the majority of participants reported being in good to very good health conditions (47.8% good; 38.7% very good-excellent), as it is shown in Table 4.2.

Body mass index (BMI). The mean BMI was 26.2 kg/m^2 (SD = 5.2; range = 17.1 – 43.0). According to WHO classification (WHO, 2011), the 45.3% of the sample was classified as 'normal' (with values ranging from 18.5 to 24.9 kg/m^2), almost one-third (31.6%) was 'overweight' (more than 25, and less than 30 kg/m^2), and 20.9% was classified as 'obese' (more than 30 kg/m^2).

A significant and negative correlation was found between gender and BMI at baseline ($r_{pb} = -.106$, $p = .035$), indicating that male participants had higher BMI levels than female participants. An independent sample t-test revealed that there was a significant difference in BMI between males (M = 27.36, n = 83, SD = 4.97) and females (M = 25.97, SD = 5.19, n = 310), but the difference was small in magnitude: $t_{(391)} = 2.111$, $p = .035$, $\eta^2 = .01$. The mean BMI for males was 1.4 BMI units (kg/m^2) higher than females: on average, men weighted significantly higher than females: $t_{(391)} = 9.396$, $p < .001$, $\eta^2 = .18$ (large effect). The mean weight difference was 18.15 kg, and was associated with a significantly high and large effect.

A significant and positive association with BMI was found with age variable ($r = .19$, $p < .001$, two-tailed). A one-way ANOVA test between age groups and BMI revealed a significant, albeit small, effect of age on BMI: $F_{(3, 389)} = 7.354$, $p < .001$, $\eta^2 = .05$. On average, younger participants reported significantly lower BMI levels compared to older age groups. In fact, the mean BMI of employees aged between 18 and 25 years 50 (M = 24.08, SD = 4.64) was 3.5 BMI units lower than those aged 50 or more (M = 27.60, SD = 5.02), 2.3 units lower than those aged from 40 to 49 years old (M = 26.36, SD = 4.99), and 2.4 units lower than those aged from 28 to 39 years (M = 26.48, SD = 5.41). The mean BMI difference between the other age groups was non-significant.

Significant differences in BMI were found also among different education levels and type of organisations (i.e., 'cluster'). Regarding education levels, the difference was significant but associated with a small effect size: $F_{(3, 364)} = 4.575$ $p = .004$, $\eta^2 = .04$. On average, the mean BMI of those who obtained an O-level degree (M = 30.19, SD = 5.58) was significantly lower than those who had obtained a higher degree (M = 26.12, SD = 5.64), lower than those who obtained an A-level (M = 25.92, SD = 4.29), and also significantly smaller from those who obtained other professional qualifications (M = 25.42, SD = 4.53). BMI significantly differed also among people working in different types of organisations: $F_{(4, 363)} = 3.229$, $p = .013$, $\eta^2 = .03$ (small effect size). On average, the mean BMI of people working in chemical companies (M = 28.83, SD = 6.10), was about 3 kg/m^2 higher than those of people working in universities (M = 25.79, SD = 5.35). Perceived health status was also positively and significantly associated with BMI at baseline ($r = .32$, $p < .001$): those who reported being in good health status reported also lower levels of BMI compared to those with lower health status: $F_{(4, 388)} = 11.327$, $p < .001$, $\eta^2 = .10$ (medium to large effect). The mean BMI for people who reported being in an 'excellent' health status at baseline (M = 22.98, SD = 3.59) was 1.66 BMI units (kg/m^2) lower than those who reported being in a 'very good health status' (M = 24.64, SD = 3.56), 3.80 units lower than those who reported a 'good' health status (M = 26.78, SD = 5.50), 6.64 units lower than those who reported a 'fair' health status (M = 29.62, SD = 7.33), and 7.48 units lower than those who reported a 'poor' health status (M = 30.46, SD = 4.90). The mean BMI of those who reported being in 'very good' health was 2.2 units lower than those who reported being in a 'good' health status, 5.1 units lower than those who reported being in 'fair' health status, and 5.9 units lower than those who reported being in a 'poor' health status. Those who reported being in 'good' health status had on average 2.9 BMI units less than those who reported being in 'fair' health status, and 3.7 units less than those who said they were in 'poor' health status. All these differences were significant at $p < .05$, whereas the mean BMI difference between those who were in the fair health status and those in the poor health category was not statistically significant.

Personal history of chronic conditions. A good health profile was reflected also in few reported chronic conditions both related to personal and family history. In fact, almost one third of the enrolled population reported that they did not suffer from any of the 17 chronic conditions listed in the survey. Another third reported having had only one disease, 19.8% two diseases, 9.4% three, 5.3% four, 2.8% five and only one participant (.3%) reported having had a maximum combination of six diseases. This case reported having been diagnosed with allergies, asthma, chronic pain, depression, heartburn or acid reflux and migraine headaches. Among those who reported at least one disease ($n = 279$), the most frequently reported chronic conditions were allergies (31.5% of the cases), followed by back problems (27.2%), asthma and depression (both 25.4%), and migraine headaches (20.1%). Menopause interested the 12.5% of the female sample, whereas heartburn or acid reflux, and high blood pressure/hypertension affected the 10% and 10.4% of the sample respectively. The remaining conditions affected less than 10% of the participants but are reported for completeness in Table 4.3.

For those who reported having had one disease ($n = 131$), the most frequent chronic diseases were asthma (17.6% of the cases), back problems (16.8%), allergies and migraine headaches (14.5%), and depression (11.5%). For those who said having had two or three disease ($n = 115$), the most frequently reported ones were allergies (19.5% of responses), depression (33.0%), asthma (30.4%), back problems (29.6%), migraine headaches (21.7%), menopause (15.7%) and heartburn or acid reflux (11.3%). For those who reported four or five chronic diseases ($n = 32$), the most frequent ones were back problems (62.5%), migraine headaches (21.7%), menopause (15.7%) and heartburn or acid reflux (11.3%).

For those who reported having had one disease (n = 131), the most frequent chronic diseases were asthma (17.6% of the cases), back problems (16.8%), allergies and migraine headaches (14.5%), and depression (11.5%). For those who said having had two or three disease (n = 115), the most frequently reported ones were allergies (19.5% of responses), depression (33.0%), asthma (30.4%), back problems (29.6%), migraine headaches (21.7%), menopause (15.7%) and heartburn or acid reflux (11.3%). For those who reported four or five chronic diseases (n = 32), the most frequent ones were back problems (62.5%), migraine headaches (21.7%), menopause (15.7%) and heartburn or acid reflux (11.3%).

Table 4.3. Frequencies and percentages of personal history of chronic conditions (n = 279)

Chronic conditions	Responses		% of cases (n = 279)
	n	%	
Allergies	88	16.2	31.5
Arthritis	13	2.4	4.7
Asthma	71	13.1	25.4
Back problems	76	14.0	27.2
Cancer	10	1.8	3.6
Chronic Pain	7	1.3	2.5
Depression	71	13.1	25.4
Diabetes	6	1.1	2.2
Heart Problems	3	.6	1.1
Heartburn or Acid Reflux	28	5.2	10.0
High Blood Pressure/Hypertension	29	5.3	10.4
High Cholesterol	22	4.1	7.9
Menopause	35	6.4	12.5
Migraine Headaches	56	10.3	20.1
Obesity	24	4.4	8.6
Osteoporosis	4	.7	1.4
Total	543	100.0	

Notes: % of cases does not add to 100% because multiple choices were allowed.

Family history of chronic conditions. The most frequently reported chronic condition was high blood pressure 46.1% of the cases, followed by heart problems (mentioned in the 37.4% of the cases), cancer (33.6%), diabetes (29%) and high cholesterol (23.7%). The other conditions are reported in Table 4.4.

Table 4.4. Frequencies and percentages of family history of chronic conditions (n = 320)

Chronic conditions	Responses n	Responses %	% of cases (n = 320)
Asthma	84	10.5	26.3
Cancer	132	16.5	41.3
Diabetes	114	14.2	35.6
High Blood Pressure	181	22.6	56.6
High Cholesterol	93	11.6	29.1
Heart Problems	147	18.4	45.9
Obesity	50	6.2	15.6
Total	801	100.0	250.3

Notes: counts and percentages do not add to 100% because multiple choices were allowed.

4.2.3 Theory of planned behaviour variables

Descriptive and distributional statistics of TPB direct measures at baseline and post-intervention follow-ups are presented in Table 4.5 below. As mentioned earlier in Chapter Three, direct measures were designed to directly assess attitudes, subjective norms, perceived behavioural control and behavioural intention. Three items were used to assess each construct. The items measuring attitude construct were: ATT1 ("For me, getting at least 30 minutes of moderate physical activity or 20 minutes of vigorous physical activity in the coming week will be: unimportant/important"); ATT2 ("For me, getting at least 30 minutes of … would be: not enjoyable/enjoyable"); and ATT3 ("For me, getting at least 30 minutes of… would be: exhausting/energising"). All attitude items were measured on 7-point bipolar scales.

Perceived behavioural control was measured through PBC1 ("I am confident that I can get at least 30 minutes of…"), PBC2 ("For me to get at least 30 minutes of moderate physical activity… would be: very difficult/very easy"); and PBC3 item ("The decision to get at least 30 minutes … is beyond my control"). PBC items were measured through 7-point scales with different endpoints. The end points for PBC2 item were very difficult/very easy; PBC1 and PBC3 were based on a 7-point Likert-type scale (strongly disagree/strongly agree).

Subjective norm construct was measured by SN1 item ("Most people who are important to me think that I should not/I should get at least 30 minutes of… "); SN2 item ("It is expected of me that I get at least…"); and SN3 item ("I feel under social pressure to get at least… etc."). Subjective norm items were measured through 7-point Likert-type scales (strongly disagree/strongly agree).

Behavioural intention was assessed through: INT1 ("I want to get at least 30 minutes of moderate physical activity or 20 minutes of activity in the coming week"); INT2 ("I intend to get at least 30 minutes of moderate…"); and INT3 ("I plan to get at least 30 minutes..."). All behavioural intention items were measured through 7-point Likert-type scales (completely disagree/completely agree).

Table 4.5. Descriptive and distributional statistics of TPB direct measures at baseline, Time 1 and Time 2 follow-ups

Variables / Items	Baseline (n = 393)				Time 1 (n = 162)				Time 2 (n = 140)			
	M	SD	Skew. (SE)	Kurt. (SE)	M	SD	Skew. (SE)	Kurt. (SE)	M	SD	Skew. (SE)	Kurt. (SE)
Attitude												
ATT1	5.27	1.59	-.58 (.12)	-.57 (.25)	5.30	1.55	-.71 (.19)	-.10 (.38)	5.51	1.40	-.87 (.21)	.08 (.41)
ATT2	4.92	1.53	-.51 (.12)	-.21 (.25)	5.16	1.46	-.49 (.19)	-.34 (.38)	5.18	1.43	-.74 (.21)	.14 (.41)
ATT3	4.90	1.57	-.50 (.12)	-.36 (.25)	5.21	1.37	-.69 (.19)	.18 (.38)	5.23	1.28	-.56 (.21)	-.20 (.41)
Perceived behavioural control												
PBC1	4.50	1.88	-.28 (.12)	-1.02 (.25)	4.42	1.91	-.20 (.19)	-1.13 (.38)	4.29	1.95	-.23 (.21)	-1.22 (.41)
PBC2	3.91	1.67	-.07 (.12)	-.80 (.25)	3.90	1.71	.07 (.19)	-.75 (.38)	3.84	1.74	-.09 (.21)	-.97 (.41)
PBC3	5.14	1.77	-.77 (.12)	-.39 (.25)	4.74	1.76	-.33 (.19)	-.91 (.38)	4.32	1.88	-.21 (.21)	-1.06 (.41)
Subjective norm												
SN1	5.60	1.28	-.54 (.12)	-.44 (.25)	5.26	1.33	-.34 (.19)	.12 (.38)	5.16	1.18	.33 (.21)	-1.28 (.41)
SN2	3.84	1.88	.13 (.12)	-1.00 (.25)	3.63	1.73	.10 (.19)	-.81 (.38)	3.96	1.68	.02 (.21)	-.67 (.41)
SN3	2.78	1.71	.68 (.12)	-.52 (.25)	2.71	1.64	.65 (.19)	-.57 (.38)	2.73	1.62	.71 (.21)	-.43 (.41)
Behavioural Intention												
INT1	5.90	1.24	-1.03 (.12)	.49 (.25)	5.59	1.46	-.71 (.19)	.28 (.38)	5.67	1.49	-1.30 (.21)	1.28 (.41)
INT2	5.24	1.60	-.70 (.12)	-.20 (.25)	4.86	1.81	-.49 (.19)	-.76 (.38)	5.00	1.76	-.77 (.21)	-.38 (.41)
INT3	5.25	1.54	-.79 (.12)	.09 (.25)	4.84	1.76	-.69 (.19)	-.59 (.38)	5.05	1.77	-.79 (.21)	-.30 (.41)

Notes: All items ranged from 1 to 7. For reasons of space and for simplicity, in the table the behavioural focus "get at least 30 minutes of moderate physical activity on at least 5 days or 20 minutes of vigorous physical activity on at least 3 days this coming week" is replaced with […] ATT1: For me, […] would be unimportant/important; ATT2: For me […] would be not enjoyable/enjoyable; ATT3: For me […] would be exhausting/energising; PBC1: I am confident that I can […] strongly disagree/strongly agree; PBC2: For me […] would be very difficult/very easy; PBC3: The decision to […] is beyond my control (reverse coded); SN1: Most people who are important to me think that I should not / I should […]; SN2: It is expected of me that I […]; SN3: I feel under social pressure to […]; INT1: I want to […]; INT2: I intend to […]; INT3: I plan to […].

4.2.4 Physical activity variables

Outcome physical activity variables were calculated following the Guidelines for data handling and analysis of the International Physical Activity Questionnaire (IPAQ Research Committee, 2005). Time responses, expressed in hours and minutes, were converted into minutes. All values below 5 minutes were recoded to zero, because participants were asked to provide time estimates for physical activities lasting at least 10 minutes. All available information was retained for calculating the summary scores for each domain. The initial physical activity variables of the full sample at baseline are shown in Table 4.6.

Table 4.6. Descriptive and distributional statistics for original physical activity scores at baseline (n = 393)

Variables	M	SD	Range	Md	IQR	Skew. (SE)	Kurt. (SE)
WPA_{T0} original	830.16	2017.79	0-17838	99.00	805.00	5.48 (.12)	37.29 (.25)
$LTPA_{T0}$ original	1261.85	1785.27	0-17838	664.00	1502.25	3.55 (.12)	20.14 (.25)
$DGPA_{T0}$ original	1434.66	1804.5	0-9810	761.79	1920.00	2.09 (.12)	4.99 (.25)
$ATPA_{T0}$ original	876.63	1075.41	0-9558	558.00	1023.00	2.96 (.12)	14.39 (.25)
$TOTPA_{T0}$ original	4403.35	4245.34	0-30336	3350.00	3818.50	2.90 (.12)	11.84 (.25)

Notes: All values are expressed in MET-min/week. WPA = total physical activity in the work domain; LTPA = total physical activity in leisure-time domain; DGPA = total physical activity in domestic and garden domain; ATPA = total physical activity in active transportation domain; TOTPA = total physical activity (sum of all domains).

Since one of the aims of the intervention was to encourage leisure time and workplace physical activities, all tests and results reported in the following paragraphs of this dissertation will focus on these two variables (LTPA and WPA), and will also include total physical activity as reference variable.

Physical activity extreme values ('Theoretical outliers'). As Table 4.6, skewness and kurtosis estimates, and the measures of central tendency suggested that all physical activity variables were positively skewed and non-normally distributed, with long tails. According to the IPAQ guidelines, outliers are defined as people who report engaging in physical activities for a total of more than 960 minutes/day (equivalent to 16 hours/day, assuming eight hours dedicated to sleep). These people can be defined as 'theoretical outliers' since they reported unrealistically high values of physical activity and hence it was not possible to include them in the analyses as these were clearly not representative of the sample. Based on these criteria, 25 cases (6%) of the baseline sample were identified as ‘theoretical outliers’ and excluded from the analysis, yielding an initial overall baseline sample of 368 cases. The same situation was found in the follow-up surveys, with 7 out of 162 respondents (4.3%) in the post-test follow-up dataset survey (Time 1) and 4 out of 140 respondents (2.9%) in the four-month follow-up survey (Time 2) were classified as ‘theoretical outliers’.

The presence of this type of outliers might be explained by the fact that the IPAQ-L instrument measures physical activity through a wide range of variables. As it has been shown in various studies, people tend to over-estimate and over-report their physical activity levels (Fillipas et al., 2010; Fogelholm et al., 2006; Hagströmer et al., 2008; Rzewnicki, Vanden Auweele, & De Bourdeaudhuij, 2003). Nevertheless, since it was not possible to verify that these people truly over-estimated their physical activities, they were removed from the analyses.

For longitudinal comparisons all ‘theoretical outliers’ in physical activity variables were sequentially excluded first from the baseline, then from the Time 1 dataset and finally from the Time 2 dataset, yielding a sample size of 361 employees. This suggests that most of the ‘theoretical outliers’ identified in the baseline survey were the same in the follow-up surveys; only seven participants were further excluded from the sample because they reported too high values of physical activity in either one of the two follow-ups.

4.2.4.1 Physical activity categorical variables

After having excluded the ‘theoretical outliers’, categorical variables could be converted from continuous physical activity variables. According to the IPAQ Guidelines (IPAQ Research Committee, 2005), three levels of physical activity are defined: high, moderate and low, and the thresholds are defined by the frequency and intensity of activities performed. “High” category includes those who engage in vigorous activities for at least 3 days a week and totalling a minimum of 1500 METs, or engage in a combination of activities 7 days a week for a minimum of 3000 METs. “Moderate” category describes those who engage in: moderate physical activities 30 minutes/day, for at least 5 days; walking for 30 minutes/day for at least 5 days; vigorous physical activities for at least 20 minutes/day for at least 3 days; or 5 days of a combination of activities for a minimum of 600 METs. “Low” category indicates those who do not meet the recommended levels of physical activity or those who are not included in the other two categories. Based on the aforementioned cut-off points, at baseline the majority of the sample (52.4%) was highly active, 41.8% was moderately active, and only about 6% was not meeting the recommended levels of physical activity. Similar proportions were found also in follow-up surveys: the percentage of those who were classified as active was 44.5% at immediate post-intervention and 47.8% at longitudinal follow-up, with an increased proportion of people being classified as moderately active. These categorical variables were used to describe participants’ by their activity type (i.e., highly active, moderately active, and insufficiently active).

Table 4.7. Categorical physical activity scores

	Baseline (n = 368)		Time 1 (n = 155)		Time 2 (n = 136)	
Categories	n	%	n	%	n	%
Low	21	5.7	13	8.4	13	9.6
Moderate	154	41.8	73	47.1	58	42.6
High	193	52.4	69	44.5	65	47.8

Notes: Categories: Low = does not meet the recommended levels or is not included in the other two categories; Moderate = at least 5 days of moderate PA for 30 minutes/day, or at least 5 days of walking for 30 minutes/day, or 3 days of vigorous PA for at least 20 minutes/day, or 5 days of a combination of activities for a minimum of 600 METs; High = at least 3 days of vigorous for a minimum of 1500 METs, or 7 days of a combination of activities for a minimum of 3000 METs. MET stands for metabolic equivalent. Categories are calculated on continuous winsorised variables.

4.3 Preliminary analysis

Preliminary analysis of survey data included the examination of the main outcome variables (physical activity and TPB core constructs) and relevant demographic background variables, by analysing frequencies and distributions for categorical variables, descriptive and distributional statistics for continuous variables. Relationships among continuous and dichotomous variables were explored through correlations, using point-biserial correlation coefficients between continuous and dichotomous variables, Spearman's rho with ordinal categorical variables (i.e., health status, education). Associations between categorical or nominal variables were assessed through Chi-square tests. Differences between groups with regards to physical activity and TPB items scores were investigated using one-way ANOVA tests between categorical and continuous outcome variables, and independent sample t-tests between dichotomous and continuous variables. All preliminary tests were implemented in IBM SPSS v19.

Following the two-step analysis strategy outlined in Chapter Three, cross-sectional and longitudinal models were tested using SEM techniques with the aid of AMOS v.19 (Arbuckle, 2010b) and Mplus v.6.12 (Muthén & Muthén, 2011). AMOS was used for its graphic capabilities and for initially inspecting the structure of the models, whereas Mplus was used for estimating the models when data required the use of specific algorithms or estimators not available in AMOS.

4.3.1 Outliers

Prior to SEM analyses, all background and main outcome continuous variables were evaluated for univariate statistical outliers, multivariate outliers, model-based and non-model based outliers, by examining frequency distributions at the univariate level and identifying scenarios where extreme scores occurred for a small number of respondents. To reduce the impact of these outliers and in order to preserve the sample size, all scores were winsorised cross-sectionally in each of the datasets.

Statistical univariate outliers. Statistical univariate outliers were identified through the outlier-labelling rule[12] (Hoaglin & Iglewicz, 1987; Hoaglin, Iglewicz, & Tukey, 1986). Age did not present any extreme cases; whereas BMI at baseline presented five extreme values and these were winsorised (see Table 4.2). Physical activity continuous variables were evaluated for statistical outliers after having excluded those who reported unreasonably high scores (see above the paragraph about 'theoretical outliers'). Inspecting the frequency distributions and boxplots revealed the presence of other extreme cases in all physical activity variables under scrutiny (WPA, LTPA and TOTPA). Through the outlier-labelling rule, the following outliers were identified at baseline (n = 368): the variable workplace physical activity (WPA) presented n = 32 outliers (8.7%), leisure-time physical activity (LTPA) n = 15 (4.1%), and the variable total physical activity (TOTPA) had one outlier (.3%). At Time 1 follow-up (n = 155), the variable WPA had n = 16 outliers (10.3%), the variable LTPA had n = 8 (5.2%), and the variable total physical activity (TOTPA) had other n = 4 outliers (2.6%). At Time 2 follow-up (n = 136), in the variable WPA there were n = 14 outliers (10.3%), in the variable LTPA there were n = 3 (2.2%), and the variable total physical activity (TOTPA) had still other n = 2 outliers (1.5%).

Based on the cut-off points identified using the outlier labelling rule, 8.7% of the scores were winsorised in the variable job-related physical activity at baseline (WPA); 4.1% of the scores were winsorised in the variable leisure-time physical activity (LTPA), and .3% of the scores was winsorised in the variable total physical activity (TOTPA). At Time 1 follow-up, 10.3% of the scores of WPA, 5.2% of LTPA and 2.6% of TOTPA scores were winsorised. At Time 2 follow-up, 10.3% of WPA, 2.2% of LTPA, and 1.5% of TOTPA scores were winsorised. In Table 4.8 below are presented comparisons between original and winsorised physical activity scores, after having excluded

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[12] The rule involves the computation of lower and upper bound using Tukey's Hinges for 25th percentile (Q1) and 75th percentile (Q3), and the interquartile spread (Q3-Q1). The lower bound was calculated as: lower bound = Q1 – ((Q3-Q1)*2.2); upper bound = Q3 + ((Q3-Q1)*2.2). Any value smaller than the lower bound or larger than the upper bound indicated a significant outlier.

'theoretical outliers' at baseline, post-test follow-up (Time 1) and four months follow-up (Time 2).

Table 4.8 Descriptive and distributional statistics for original and winsorised physical activity variables

Variables	M	SD	Range	Skew. (SE)	Kurt. (SE)
Baseline (n = 368)*					
1a. WPA original	540.17	937.32	.00 – 4788.00	2.26 (.12)	4.80 (.25)
1b. WPA winsorised	446.88	667.62	.00 – 2030.40	1.47 (.13)	.73 (.25)
2a. LTPA original	1089.22	1352.35	.00 – 8772.00	2.32 (.12)	7.25 (.25)
2b. LTPA winsorised	1031.99	1138.92	.00 – 4284.93	1.39 (.13)	1.30 (.25)
3a. TOTPA original	3664.15	2556.63	.00 – 13224.00	1.05 (.12)	1.07 (.25)
3b. TOTPA winsorised	3662.37	2550.17	.00 – 12568.95	1.03 (.13)	.98 (.25)
Time 1 (n = 155)*					
1a. WPA original	633.65	1494.82	.00 – 12570.00	4.71 (.19)	29.65 (.38)
1b. WPA winsorised	393.19	606.86	.00 – 1776.09	1.43 (.20)	.55 (.39)
2a. LTPA original	1255.67	1723.57	.00 – 13572.00	3.49 (.19)	18.19 (.38)
2b. LTPA winsorised	1134.78	1223.51	.00 – 4412.40	1.41 (.20)	1.21 (.39)
3a. TOTPA original	3724.99	3294.53	.00 – 16344.00	1.65 (.19	3.02 (.38)
3b. TOTPA winsorised	3681.48	3145.03	.00 – 13681.55	1.42 (.20)	1.85 (.39
Time 2 (n = 136)*					
1a. WPA original	567.04	1195.48	.00 – 7070.00	3.44 (.21)	13.13 (.41)
1b. WPA winsorised	361.31	512.60	.00 – 1457.98	1.29 (.21)	.12 (.41)
2a. LTPA original	1208.79	1459.06	.00 – 9360.00	2.72 (.21)	11.12 (.41)
2b. LTPA winsorised	1150.06	1198.36	.00 – 5204.10	1.37 (.21)	1.83 (.41)
3a. TOTPA original	3410.26	2823.86	.00 – 17706.00	1.74 (.21)	4.66 (.41)
3b. TOTPA winsorised	3347.30	2579.36	.00 – 10919.70	1.10 (.21)	.65 (.41)

Notes: All measures are expressed in MET-minutes/week. * These estimates do not include 'theoretical outliers'

Physical activity variables were finally rescaled to MET-hours/week in order to reduce the metric gap with the 7-point scale items used for assessing TPB construct indicators. Physical activity rescaled variables are shown in Table 4.9.

Table 4.9 Descriptive and distributional statistics for rescaled winsorised physical activity variables

Variables	M	SD	Range	Skew. (SE)	Kurt (SE)
Baseline (n = 368)					
1. WPA winsorised	7.45	11.13	.00 - 33.84	1.47 (.12)	.73 (.25)
2. LTPA winsorised	17.21	18.99	.00 - 71.42	1.39 (.12)	1.29 (.25)
3. TOTPA winsorised	57.27	36.71	.00 - 188.04	.81 (.12)	.60 (.25)
Time 1 (n = 155)					
1. WPA winsorised	6.55	10.11	.00 - 29.60	1.43 (.20)	.55 (.39)
2. LTPA winsorised	18.91	20.39	.00 - 73.54	1.41 (.20)	1.21 (.39)
3. TOTPA winsorised	53.87	38.75	.00 - 181.04	.84 (.20)	.05 (.39)
Time 2 (n = 136)					
1. WPA winsorised	6.02	8.54	.00 - 24.30	1.29 (.21)	.12 (.41)
2. LTPA winsorised	19.17	19.97	.00 - 86.74	1.37 (.21)	1.83 (.41)
3. TOTPA winsorised	50.58	34.60	.00 - 185.68	.91 (.21)	.83 (.41)

Notes: All measures are expressed in MET-hours/week. These estimates do not include 'theoretical outliers'

Multivariate outliers. Multivariate outlier analysis was pursued using non-model based and model-based techniques. For non-model based outliers, multivariate outliers were identified by examining leverage indices for each individual and defining an outlier as a leverage score four times greater than the mean leverage. The average leverage is defined as (k + 1)/n, where k is the number of predictors in the model and n is the number of participants (Field, 2009, p. 217). At baseline, the mean leverage score with a sample size n = 361 and with all relevant variables in the model (k = 26) used as predictors was .0747, hence the cut-off point was .299. No outliers were found. At Time 1 follow-up, the average leverage value was .182 and the cut-off point was .729, considering the same amount of predictors and a sample size of those who completed the survey (n = 148). No outliers were found. Lastly, at Time 2 follow-up, the average leverage and cut-off point were .209 and .837 respectively, with k = 26 predictors and n = 129. Also in the Time 2 follow-up no outliers were found outside this threshold.

Model-based diagnostic techniques involved the analysis and inspection of ordinary least squares (OLS) regression indices for each linear equation implied by the overall models to be tested. Using a limited information approach, all endogenous variables were regressed on the indicators of the exogenous variables in the models at baseline, Time 1 and Time 2 follow-ups, and also longitudinally, according to an autoregressive cross-lagged model. Given that multiple indicators for each TPB construct were assessed (i.e., latent exogenous variables), one indicator was randomly chosen as a reference in the regression. For example, from a cross-sectional point of view, the INT2 indicator was regressed on all three available indicators of attitude, then on the indicators of subjective norms and on those of PBC. Physical activity behaviour (declined as WPA, LTPA and TOTPA respectively) was regressed on the three indicators of behavioural intention at each time point. In the longitudinal model, each selected indicator of the construct was regressed on itself at each time point. As indicators of potential multivariate outlying cases, standardised Dfbetas were inspected for absolute values larger than 1.0.

Based on these criteria, no outliers were identified at baseline. However, in the follow-up surveys, a small number of outliers were identified. At Time 1 follow-up, an absolute standardised Dfbeta larger than 1.0 was found in one case (ID: 220) for the model intention regressed on attitude indicators. The issue was associated with one indicator of attitude (ATT1), which also showed problems in internal consistency and reliability in confirmatory factor analysis context further described. Another outlying case (ID: 50) was found in the model with workplace physical activity (WPA) regressed on intention indicators, with the issue present in INT2 and INT3 indicators. At Time 2 follow-up, a case (ID: 339) with absolute standardised Dfbeta larger than 1.0 was found in two regression models. The first was intention regressed on attitude indicators (the problem was with the indicator ATT3), and the second was intention regressed on PBC indicators (the problem was found with the indicator PBC1). Another case (ID: 112) was found in the model regressing leisure-time physical activity (LTPA) at Time 2 on itself at Time 1. Another case (ID: 110) was found in the models regressing baseline total physical activity (TOTPA) on itself at Time 2 and total physical activity (TOTPA) at

Time 2 on total physical activity at Time 1. In total, five cases (ID: 50, 110, 112, 220, 339) were considered model-based multivariate outliers, given the criteria of absolute values of standardised Dfbetas larger than 1.0.

Separate analyses were conducted with and without these outliers in models involving variables collected at Time 1 and Time 2. Conclusions did not differ in the analyses; therefore all the reported results include the outliers.

4.3.2 Non-normality

All main outcome variables presented some elements of non-normality. For instance, all physical activity variables had positive skewness and large values for kurtosis (i.e., they were leptokurtic), with absolute values of skewness ranging from 2.1 and 5.5, and kurtosis ranging from 4.9 and 37 (see Table 4.6). After the exclusion of 'theoretical outliers' (see paragraph 4.3.1) and after winsorisation, relevant physical activity variables (WPA, LTPA, TOTPA) presented no skewness above an absolute value of 1.50 and no kurtosis above an absolute value of 1.32, as Table 4.9 shows. Winsorisation restrained the absolute values of skewness and kurtosis to a more acceptable range. In fact, literature suggests that values below 3.0 for skewness and below 10.0 for kurtosis are acceptable for SEM (Kline, 2005, p. 50), so the models were estimated using the default maximum likelihood estimator (ML) as implemented in AMOS. However, since the ratios between the absolute skewness and kurtosis estimates and their respective standard errors were larger than 1.96 in all physical activity variables and in some TPB items, it was suspected that the items could have been biased by the non-normality of the data at the univariate level.

Therefore, to account for non-normality, the models were also tested using a robust maximum likelihood estimator (MLR), based on the Huber-White robust estimator (Cheung, 2007), as implemented in Mplus. If the results were similar to those obtained through the default estimator and if the differences were not considerable, the normality correction was considered superfluous. When the MLR estimator was used, the Chi-square difference test was corrected using the Satorra-Bentler correction (Satorra &

Bentler, 2001; Muthén & Muthén, n.d.). In the following paragraphs the estimates presented are based on the maximum likelihood estimator, unless otherwise indicated.

4.3.3 Missing data

In the MoveM8 dataset two types of missing data were identified: missing due to non-response and missing due to attrition (Little & Rubin, 1987, 1989). The first type of missing data affected each survey dataset from a cross-sectional point of view. This means that some people did not provide answers to some of the questions in baseline and follow-up surveys (Time 1 and Time 2). The second type of missing data depends on attrition or simply because not all respondents provided answers at each time point. Missing value analysis with the full dataset was conducted with the MVA and Multiple Imputation packages in IBM SPSS Statistics v.19.

4.3.3.1 Item non-response at baseline, Time 1 and Time 2

Missing values were found in the variable age (only at baseline) and in the IPAQ time variables (days and minutes), which were used to compute the main outcome variables, such as the physical activity scores in the four domains sub-scores (WPA, LTPA, DGPA, ATPA) and total physical activity (TOTPA). There was only one missing value (.2%) in the age variable because a person did not provide their date of birth correctly. It was decided to replace that value with the mean of the variable.

Missing data in the IPAQ variables required more attention, because they affected almost every single time variable that was needed to compute total vigorous, moderate and walking activities in the four domains (WPA, LTPA, DGPA, ATPA). Missing values affected the 11 total time variables (minutes spent in physical activities multiplied by the number of days) in each vigorous, moderate and walking activities, in the four domains mentioned above. IPAQ guidelines recommend to exclude cases with any missing values in either days or minutes (or hours) spent in physical activity (IPAQ Research Committee, 2005, p. 10). Although listwise deletion is very popular and commonly utilised, this approach can be problematic in many ways, because it represents “a threat to statistical power and also to the validity of statistical inference” (Fichman & Cummings, 2003, p. 7). In this study, listwise deletion would have excluded 108 cases (27.5%) of the total initial sample (N = 393), 46 cases (28.4%) in the follow-up sample (n = 162), and 32 cases (22.9%) in the 4-months follow-up survey (n = 140). Hence, it was decided to use alternative strategies, in order to preserve as much information as possible.

In the baseline dataset, the total amount of missing values in these variables was on average 2.6% (range 0% - 5.6%), and Little’s MCAR test was statistically non-significant (χ^2 = 186.866, df = 199, p = .722). In the post-test follow-up survey (Time 1), missing data were on average 1.5% (range 0% - 4.9%) and Little’s MCAR test was statistically non-significant (χ^2 = 70.857, df = 91, p = .942). In the 4-months follow-up survey (Time 2), the average missing data was 2.1% (range 0% - 5.7%) and Little’s MCAR test was also non-significant (χ^2 = 43.356, df = 85, p = 1.000). Hence, it was decided that mean substitution could be applied to the 11 time variables (minutes or hours), so that the calculation of the composite outcome variables in the four physical activity subdomains and total physical activity could be undertaken.

4.3.3.2 Missing data due to attrition

Analysing each single dataset separately, attrition caused 58.8% of the missingness at Time 1 and 64.4% of the missingness at Time 2. However, when considering the full dataset, attrition accounted for the 73.8% of the missingness in the dataset. In fact, of the total sample of participants who completed the baseline survey (N = 393), only 103 (26.3%) completed both follow-up surveys at Time 1 and Time 2.

4.3.3.3 Missing value patterns

Four types of missing value patterns were found in the full dataset including baseline, Time 1 and Time 2 data. The first pattern represents cases with no missing data, the second represents cases with missing data at Time 1, the third is for cases with missing at Time 2 and, the fourth is for cases with missing data at both Time 1 and Time 2 variables. Almost 50% of the cases in the dataset had pattern 4, so those cases with missing data at both Time 1 and Time 2. The second most frequent pattern was number one, with no missing values in all surveys. This pattern represented the 26.3% of those who completed all surveys (103 participants out of 393). Almost 15% of the cases did not complete the survey only at Time 1 (pattern 3) and about 10% did not respond only to Time 2 (pattern 2). The missing value patterns graph showed that the pattern was arbitrary (Schafer & Graham, 2002) and was nonmonotone, because almost half of the sample did not complete all follow-up surveys, some did not complete only the Time 1 survey or only the Time 2 survey. A monotone pattern of missing data can be identified by first ordering the variables according to the amount of missing data, then by identifying whether a missing pattern is related to the amount of data missing in some units: "if Y_j is missing for a unit, then $Y_{j+1}, \ldots, Y_p$ are missing as well" (Schafer & Graham, 2002, p. 150). Some authors argued that monotone patterns can be present in longitudinal studies, however, Horton and Kleinman noted that "a monotone pattern is uncommon in most realistic settings" (Horton & Kleinman, 2007, p. 80). A monotone pattern would have implied that people who did not complete Time 1 were forced to drop-out to the study, so that they could not complete the survey at Time 2, but this was not the case, as participants were considered part of the study unless they actively asked to be excluded from the intervention.

Attrition bias was assessed by creating a series of dummy variables indicating missing data only at Time 1, at Time 2 and at both Time 1 and Time 2. Point-biserial correlations were used to investigate possible associations between missingness at Time 1 or Time 2 and all continuous variables in the dataset, namely age, physical activity variables and TPB variables. Almost all correlations with the dummy variables were not statistically significant, and those that were significant, were associated with a small effect size. For example, a small positive correlation was found between the subjective norm score and missingness at Time 1 ($r_{pb} = .168$, $p = .001$), and Time 2 ($r_{pb} = .167$, $p = .001$), with both variables sharing about 2% of the variance ($R^2 = .02$). On average, participants who did not respond to post-test follow-up survey (Time 1) scored .36 units higher on the overall direct social norm scale at baseline ($t_{(391)} = -3.148$, $p = .002$). Those who did not respond to 4-months follow-up survey (Time 2) scored .40 units higher on the overall direct social norm scale at baseline ($t_{(391)} = -2.959$, $p = .003$).

A Chi-square test for independence (with Yates Continuity Correction) was used to assess the associations between dichotomous variables (i.e., gender and group) and missingness at Time 1 and Time 2. No significant associations were found between gender or group and missingness at Time 1 o Time 2. The relationships between missingness at Time 1 and Time 2 and other categorical variables, such as enrolment wave, cluster, education, BMI (categorical), work status, health status, family status, age groups and baseline physical activity (categorical) were also inspected.

A significant association with missingness at Time 1 was found in baseline perceived health status groups ($\chi^2 = 10.356$, $p = .035$, Cramer's V = .16), and baseline physical activity categories ($\chi^2 = 6.846$, $p = .033$, Cramer's V = .13), indicating a significant difference in proportions between health status categories and physical activity categories. In particular, the majority of those who were in good health status did not complete Time 1 questionnaire and the majority of those who were classified as 'highly active' did not complete Time 1 questionnaire. However, these differences disappeared at Time 2. Consequently, it can be concluded that over all participants who did not complete all the follow-up surveys did not differ significantly from those who completed all surveys.

4.3.3.4 Strategies to deal with missing data

Although the differences between participants who responded and did not respond to the surveys were not substantial, the attrition rates were high and a large amount of data was missing from follow-up surveys. When dealing with large amounts of missing data two 'state of the art' strategies are available: multiple imputation and maximum likelihood estimation (e.g., Elobeid et al., 2009; Graham, 2009; Schafer & Graham, 2002). Multiple imputation is a Monte Carlo technique in which missing values are imputed, that is replaced by a set of $m > 1$ simulated versions (datasets) calculated using original observed data. In other terms, multiple imputation techniques provide multiple sets of plausible values. Maximum likelihood estimation is a technique in which missing values are estimated rather than imputed, and estimates are based on a log likelihood algorithm. Multiple imputation is implemented in several statistical software, including IBM SPSS Statistics and Mplus, whereas maximum likelihood (based on a full-information maximum likelihood algorithm) is implemented in specialised SEM software packages, such as AMOS and Mplus. Methodology literature clearly suggests that both maximum likelihood and multiple imputation approaches outperform traditional methods to deal with missing data (Newman, 2003), and both approaches can be safely used in conjunction with missing longitudinal data (Graham, 2009, p. 562). Traditional methods, which include for example pairwise or listwise deletion, are considered more prone to biasing estimates (e.g., Baraldi & Enders, 2010; Blankers, Koeter, & Schippers, 2010; Graham, 2009; Honaker & King, 2010; Kristman, Manno, & Côté, 2005; Peng, Harwell, Liou, & Ehman, 2006; Peugh & Enders, 2004; Raghunathan, 2004; Rubin, Witkiewitz, St. Andre, & Reilly, 2007; Scheffer, 2002; Twisk & de Vente, 2002). For instance, in this study, using traditional procedures (such as the default listwise deletion) would produce biased estimates, since the pattern of missing data was not missing completely at random (MCAR).

Many authors encourage the adoption of maximum likelihood methods (e.g., full-information maximum likelihood) as alternatives to multiple imputation in SEM (Olinsky, Chen, & Harlow, 2003), and specifically in the context of longitudinal studies (Raykov, 2005; Raykov & Marcoulides, 2010). Full information maximum likelihood (FIML) estimation is a recommended approach also because it can be used in combination with modern robust algorithms that deal with non-normality (Shin, Davison, & Long, 2009). Additionally, in a recent simulation study, which compared the performance of FIML and MI in the presence of a second-level dependency in multilevel setting (Larsen, 2011), FIML outperformed MI. Therefore, in the current study, to missing data were dealt with FIML as implemented in AMOS and Mplus, when tested models involved longitudinal comparisons.

4.3.4 Statistical power and sample size

Sensitivity power analysis for correlations and mean difference tests

Considering the decreased sample size from baseline to Time 2, sensitivity power analyses were conducted for: point-biserial correlations, bivariate normal correlations, independent sample t-tests, and one-way ANOVA tests, in order to determine the minimum effect size required to obtain statistical significance with 80% and 95% likelihood, following Balkin and Sheperis' (2011) recommendations. Power calculations were computed using G*Power 3 software (Faul, Erdfelder, Lang, & Buchner, 2007). Several scenarios were tested, varying the sample sizes and power levels accordingly. All tests were conducted assuming an alpha level of .05, a minimum power of .80, a two-tailed distribution, and the sample sizes n = 368 for baseline, n = 155 for Time 1, and n = 136 for Time 2 follow-ups from a cross-sectional point of view. Tables with all tested scenarios and relative estimates are included in Annex A.

Baseline data (n = 368). For point-biserial correlations, the estimated minimum effect size for obtaining statistical significance was $|\rho| = .14$, corresponding to a coefficient of determination $r^2 = .02$. Both measures of effect sizes are considered small, according to Cohen's guidelines (1988). For bivariate correlations, assuming a H_0 correlation $\rho = .05$, the estimated critical effect size was: $r = \pm.10$, and a H_1 correlation $\rho = .15$ (corresponding to $r^2 \geq .02$). For t-tests, the 'Critical t' to obtain a minimum effect size d was $t_{(366)} = 1.966$, associated with an effect size d = .37, corresponding to eta squared $\eta^2 = .01$ (small effect). For one-way ANOVA tests, the estimated 'Critical F' and effect size 'f' varied in function of the number of groups (or categories) of a variable: with six groups: Critical $F_{(5, 362)} = 2.239$, f = .23 (corresponding to $\eta^2 = .05$); with five groups: Critical $F_{(4, 363)} = 2.397$, f = .22, $\eta^2 = .05$; with four groups: Critical $F_{(3, 364)} = 2.629$, f = .22, $\eta^2 = .05$; with three groups: Critical $F_{(2, 365)} = 3.020$, f = .021, $\eta^2 = .04$, achieving a small to medium effect. Effect sizes d, f and η^2 were converted among each other using the formulas found in Aaron, Kromrey and Ferron's article (1998).

Time 1 data (n = 155). For point-biserial correlations, the estimated minimum effect size was $|\rho| = .22$, corresponding to a coefficient of determination $r^2 = .05$ (small to medium). For bivariate correlations, the critical r was ± .13, and a H_1 correlation ρ = .20. For t-tests, the critical $t_{(153)} = 1.976$, associated with an effect size d = .60 ($\eta^2 = .02$). For one-way ANOVA tests, the estimated 'Critical F' and effect size 'f' were for six groups: Critical $F_{(5, 149)} = 2.275$, f = .36 ($\eta^2 = .12$); for five groups: Critical $F_{(4, 150)} = 2.432$, f = .35, $\eta^2 = .11$; for four groups: Critical $F_{(3, 151)} = 2.665$, f = .34, $\eta^2 = .10$; with three groups: Critical $F_{(2, 365)} = 3.056$, f = .032, $\eta^2 = .09$.

Time 2 data (n = 136). For point-biserial correlations, the estimated minimum effect size was |ρ| = .24, corresponding to a coefficient of determination $r^2 = .06$. The critical effect size for bivariate correlations was r = ± .14, and a H_1 correlation ρ = .21. For t-tests, critical $t_{(134)} = 1.978$, d = .59 ($\eta^2 = .03$). For one-way ANOVA tests, the estimated 'Critical F' for six groups was: Critical $F_{(5, 130)} = 2.284$, f = .39 ($\eta^2 = .13$); for five groups: Critical $F_{(4, 131)} = 2.441$, f = .38, $\eta^2 = .12$; for four groups: Critical $F_{(3, 132)} = 2.673$, f = .36, $\eta^2 = .12$; with three groups: Critical $F_{(2, 133)} = 3.064$, f = .034, $\eta^2 = .09$.

Statistical power for SEM tests

Structural equation modelling is based on asymptotic statistical theory, which involves large samples. Statistical power is associated to hypothesis testing and to the probability of rejecting the null hypothesis when the alternative hypothesis is true. Also in SEM framework, hypothesis testing and the statistical power when inferring causal relationship between variables depend on the population model, significance level, degrees of freedom and sample size (MacCallum, Browne, & Sugawara, 1996). Some authors recommend as 'rule of thumbs' sample sizes ranging from 100 to 200 observations (Kline, 2005), while others advice to consider sample size (N) in terms of number of parameters (q) to be estimated, and suggest to use at least 10:1 or even 20:1 for more accurate calculations (Kline, 2005, p. 178). The N:q ratio approach has been supported by some evidence (Jackson, 2003).

Another way to determine an appropriate sample size is calculating the *critical N* (CN) statistic, as developed by Hoelter in 1983 and reported by Schumacker and Lomax (2004, p. 115). Critical N is given as $CN = (Chi\text{-}square/F_{ML}) + 1$. F_{ML} is the maximum likelihood fit function for a specified model. CN indicates the sample size that "would make the obtained Chi-square from a structural equation model significant at the stated level of significance" (Schumacker & Lomax, 2004, p. 49). In other terms, the Critical N statistic indicates the sample size at which the maximum likelihood fit function F_{ML} leads to a rejection of the null hypothesis (Schumacker & Lomax, 2004, p. 115). The CN statistic is output in AMOS software.

To determine the actual achieved power (*a posteriori*) a limited information approach was used (see Kline, 2005, p. 156). This approach consists of estimating the power of a test at a level of individual paths or unstandardized regression coefficients in a multiple regression context, in which the guidelines proposed by Cohen (1988) can be applied. This technique uses traditional power analysis software to gain a sense of sample size demands (Jaccard & Wan, 1996) and is also amenable of hand calculation. This approach provides a rough approximation of statistical power and requires that the alpha level, the desired level of power (e.g., $1 - \beta = .80$), and the population proportion of unique variance explained by the direct effect of interest are specified, in order to estimate the minimum sample size needed to obtain those values (Kline, 2005, p. 156). G*Power 3 software (Faul et al., 2007) was used to compute statistical power analysis for a predictor that accounts for at least 5% of unique variance in the outcome. Different scenarios were tested, including the minimum, the most typical and the maximum number of predictors in a linear equation both for cross-sectional and longitudinal comparison.

Cross-sectionally, the most typical number of predictors in the set of linear equations implied by the model was three (e.g., intention regressed on attitudes, subjective norms, perceived behavioural control), and the minimum was one (e.g., the path from intention to behaviour). If covariates were added to control for background factors that showed some significant correlations with the TPB constructs as well as with physical activity variables at baseline (i.e., gender, education level, and health status), thus the maximum number of predictors per variable was considered six.

All tests assumed an alpha level of .05 (two-tailed), 5% of minimum explained variance in the outcome variable, and a squared multiple correlation of .20 (for more than one predictor). The sample size of n = 368, used for initial baseline CFA and structural models[13], yielded a power of .99 with one predictor, and 1.00 with three and six predictors. If the sample was split in half for multi-group analysis (n = 184), which was used to assess moderation of measurement invariance, the power was estimated to be .99 for one, three and six predictors. A sample size of 155, which corresponded to the number of people who successfully completed Time 1 follow-up (excluding 'theoretical outliers'), yielded a power of .80 for one parameter, and .99 for both three and six parameters. Lastly, the sample size of 136, which corresponds to the number of completed surveys at Time 2, yielded a power of .74 with one predictor and a power of .99 with three and six predictors.

Longitudinally, the most typical number of potential predictors in a set of linear equations was three, and the maximum number of potential predictors was six. This is the case of intention at Time 2 predicted by attitudes, subjective norms and perceived behavioural control at Time 2, intention at Time 1, intention at baseline, and behaviour at Time 1. Therefore the scenarios in which the power was estimated included one, three and six parameters. Including a maximum of three variables as covariates in the model (e.g., gender, education level, and health status) in order to control for background factors, would increase the number of predictors to nine. Similarly to the cross-sectional tests, the assumptions were: an alpha level of .05 (two-tailed), 5% minimum explained variance in the outcome variable, a squared multiple correlation of .20 (for more than one predictor). For longitudinal analyses, the maximum retainable sample size was 361, which excluded 'theoretical outliers' on the main outcome physical activity variables in all three points in time. It can be concluded that sample sizes of 368 and 361 yielded a satisfactory power for the proposed model analyses, from a cross-sectional and longitudinal point of view. For longitudinal analyses, a sample of n = 361 was used and the missing data were dealt with FIML as implemented in AMOS and Mplus.

[13] This corresponds to the initial sample of 393 minus the 25 'theoretical outliers' identified in paragraph 4.3.1.

4.3.5 Clustering

Cluster effects were investigated by examining intra-class correlations (ICC) between the variable ‘cluster’ (i.e., type or workplace) and the other variables in the model. Cluster variable included five clusters (k = 5). Intra-class correlation (ICC) is a ratio of between variance (between clusters) over total variance (between + within variance) for a given variable (Kenny & Judd, 1986). ICCs were calculated using a mixed model procedure in IBM Statistics v19, with each variable in the model treated as dependent variable, and cluster variable treated as random effect. Additionally, to determine whether the clustering effect was statistically significant, one way ANOVA tests were conducted with each variable treated as dependent variable, and cluster as grouping variable, as described in Kenny & La Voie (1985). At baseline, ICCs were zero or close-to-zero in all main outcome variables to be used in SEM model. This means that two individuals randomly selected from the same cluster were not more likely to have similar scores than a pair of randomly selected individuals representing a different cluster. No statistically significant effects were found in Time 1 TPB and physical activity outcome variables, whereas at Time 2, cluster variable presented a significant design effect[14] on workplace physical activity ($F_{(4,\ 135)} = 2.870$, $p = .03$, $\eta^2 = .08$, $f = .30$, design effect = 2.27) and total physical activity ($F_{(4,\ 135)} = 2.884$, $p = .03$, $\eta^2 = .08$, $f = .30$, design effect = 2.42). The intra-class correlations for these two variables were respectively .15 and .17; however these differences were associated with moderate effects. Based on these results, a correction for clustering effects (implemented only in Mplus) was used in models that included the physical activity variables measured at Time 2.

[14] A design effect can be calculated as 1 + (Avg. cluster size - 1)* ICC, and it should be accounted for when it is larger than 2.0 (see Muthén, 1999). ICC stands for intra-class correlation. The significance of the design effect was calculated through an F-test based on the ratio between the mean square between (MSB) and mean square within (MSW), with df1 = k-1, df2 = k(n' - 1), with k being the number of clusters and n' the average cluster size. The average cluster size (n') was calculated using the following formula = $N^2 - \sum_j^i n^2/N(k-1)$, as discussed in Kenny & La Voie (1985).

4.3.6 Exploring relationships with physical activity and TPB variables

Associations between the main outcome variables (physical activity continuous variables, and the TPB variables) were inspected using bivariate correlations. Inter-item associations among TPB items and physical activity variables are presented in Table 4.10 for baseline, in *Table 4.11* for Time 1, and in Table 4.12 for Time 2. Based on the criteria and cut-off points identified through the sensitivity power analysis, correlations above $r = .27$ for all time points yielded sufficient power to be considered valid. TPB measures showed significant associations among items measuring the same construct over time, except subjective norm items, which were not as strongly correlated between each other as the other TPB items.

Most TPB items were positively and significantly associated with leisure-time physical activity (LTPA). At baseline, LTPA was moderately associated with all items measuring attitudes towards physical activity, with perceived behavioural control items PBC1 and PBC2, with subjective norms SN2 item, and with all behavioural intention items. A similar pattern of relationships was found in baseline total physical activity (TOTPA). These results suggested that the higher was the level of leisure-time and total physical activity at baseline, the higher were also the scores on attitudes, subjective norms, perceived behavioural control and behavioural intention item scales. Conversely, the baseline measure of workplace physical activity (WPA) was not significantly associated with any of the items used to assess TPB constructs. At Time 1, WPA was negatively associated with the PBC3 item (which was reverse coded) and at Time 2 WPA was positively associated with PBC1 and PBC2, indicating that the higher the level of physical activity in the work domain was, the higher the scores of these items were.

Past behaviour (baseline physical activity) was also strongly associated with prospective behaviour measured at Time 1 and Time 2. In particular, baseline workplace physical activity (WPA) was moderately and positively associated with WPA at Time 1 ($r = .47$, $p < .001$), and with WPA at Time 2 ($r = .52$, $p < .001$), sharing 22% and 27% of the variance with these two variables. Baseline leisure-time physical activity (LTPA) was also strongly associated with LTPA at Time 1 ($r = .55$, $p < .001$), and LTPA at Time 2 ($r = .49$, $p < .001$): the two variables shared about 31% and 33% of the variance. Lastly, baseline total physical activity (TOTPA) was significantly associated with TOTPA at Time 1 ($r = .49$, $p < .001$), and TOTPA at Time 2 ($r = .33$, $p < .001$), sharing about 24% of the variance with these two variables.

Significant differences were found across the three activity types (i.e., highly active, moderately active and insufficiently active) in most of the TPB items, confirming the existence of positive and significant correlations with these variables at all three time points, indicating that employees who were classified as “highly active” at baseline scored significantly higher than participants who were moderately or insufficiently active on most TPB items.

Table 4.10. Inter-item correlations between TPB items and physical activity variables at baseline (n = 368)

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Attitude														
1. ATT1	1													
2. ATT2	.53**	1												
3. ATT3	.49**	.66**	1											
Perceived behavioural control														
4. PBC1	.47**	.37**	.30**	1										
5. PBC2	.31**	.25**	.25**	.61**	1									
6. PBC3	.20**	.05	.12*	.37**	.49**	1								
Subjective norm														
7. SN1	.22**	.13*	.09	.12*	.02	.02	1							
8. SN2	.29**	.21**	.19**	.37**	.27**	.09	.34**	1						
9. SN3	.11*	-.03	-.08	.03	.08	-.09	.21**	.20**	1					
Behavioural intention														
10. INT1	.52**	.45**	.39**	.38**	.29**	.17**	.22**	.34**	.04	1				
11. INT2	.48**	.37**	.30**	.63**	.53**	.32**	.16**	.40**	.06	.61**	1			
12. INT3	.49**	.37**	.26**	.63**	.53**	.37**	.16**	.46**	.09	.57**	.77**	1		
Behaviour														
13. $WPA_{(T0)}$	.09	.01	.01	.09	.01	-.06	.09	.07	.09	.05	.04	.01	1	
14. $LTPA_{(T0)}$	.31**	.31**	.27**	.31**	.25**	.10	.05	.19**	.01	.25**	.29**	.29**	.06	1
15. $TOTPA_{(T0)}$	.25**	.19**	.15**	.25**	.12*	.02	.12*	.15**	.02	.17**	.25**	.22**	.42**	.54**

Notes: WPA is workplace physical activity; LTPA is leisure-time physical activity; TOTPA is total physical activity. $_{(T0)}$ indicates baseline physical activity measures; * $p < .05$; ** $p < .001$.

Table 4.11. Inter-item correlations between TPB items and physical activity variables at Time 1 (n = 155)

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Attitude																	
1. ATT1	1																
2. ATT2	.56**	1															
3. ATT3	.45**	.68**	1														
PBC																	
4. PBC1	.60**	.48**	.44**	1													
5. PBC2	.46**	.34**	.33**	.71**	1												
6. PBC3	.25**	.16*	.13	.44**	.44**	1											
Subjective norm																	
7. SN1	.48**	.31**	.27**	.24**	.13	-.03	1										
8. SN2	.49**	.28**	.16*	.48**	.41**	.24**	.38**	1									
9. SN3	.19*	-.08	-.14	.09	.14	-.08	.21**	.28**	1								
Behavioural intention																	
10. INT1	.65**	.62**	.53**	.49**	.46**	.25**	.36**	.42**	.12	1							
11. INT2	.70**	.55**	.44**	.82**	.68**	.42**	.35**	.55**	.17*	.67**	1						
12. INT3	.65**	.51**	.41**	.81**	.67**	.44**	.34**	.57**	.18*	.66**	.92**	1					
Behaviour																	
13. $WPA_{(T1)}$	-.06	.05	.07	-.06	-.16	-.27**	-.04	-.04	-.03	-.06	-.09	-.06	1				
14. $LTPA_{(T1)}$	.27**	.24**	.18*	.30**	.26**	.11	.10	.19*	.16*	.21**	.30**	.25**	.04	1			
15. $TOTPA_{(T1)}$	.15	.18*	.14	.15	.12	-.02	.08	.20*	.08	.12	.19*	.16*	.44**	.55**	1		
16. $WPA_{(T0)}$	.05	.07	.05	.12	.01	.01	.14	.15	.16*	-.03	.08	.10	.47**	.01	.27**	1	
17. $LTPA_{(T0)}$	.27**	.29**	.29**	.45**	.33**	.25**	.10	.25**	-.01	.28**	.39**	.39**	.06	.55**	.36**	-.01	1
18. $TOTPA_{(T0)}$	.23**	.27**	.19*	.38**	.28**	.22**	.10	.29**	.06	.26**	.35**	.35**	.24**	.38**	.49**	.47**	.69**

Notes: WPA is workplace physical activity; LTPA is leisure-time physical activity; TOTPA is total physical activity. $_{(T0)}$ denotes baseline physical activity measures; $_{(T1)}$ denotes Time 1 physical activity measures; * $p < .05$; ** $p < .001$.

Table 4.12. Inter-item correlations between TPB items and physical activity variables at Time 2 (n = 136)

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Attitude																	
1. ATT1	1																
2. ATT2	.62**	1															
3. ATT3	.54**	.74**	1														
PBC																	
4. PBC1	.55**	.48**	.40**	1													
5. PBC2	.46**	.41**	.36**	.75**	1												
6. PBC3	.19*	.07	.04	.32**	.35**	1											
Subjective norm																	
7. SN1	.32**	.20*	.24**	.10	.17*	-.03	1										
8. SN2	.38**	.21*	.16	.37**	.41**	-.03	.20*	1									
9. SN3	.17*	.00	.09	.21*	.25**	-.11	.11	.42**	1								
Behavioural intention																	
10. INT1	.51**	.54**	.51**	.51**	.34**	.04	.27**	.36**	.15	1							
11. INT2	.60**	.49**	.47**	.83**	.70**	.30**	.20*	.37**	.28**	.64**	1						
12. INT3	.61**	.50**	.48**	.78**	.69**	.28**	.23**	.39**	.25**	.64**	.88**	1					
Behaviour																	
13. $WPA_{(T2)}$	.05	.09	.02	.24**	.21*	.01	.09	.17*	.14	.09	.15	.13	1				
14. $LTPA_{(T2)}$	.31**	.36**	.31**	.49**	.32**	.22**	-.03	.18*	.12	.28**	.46**	.42**	.13	1			
15. $TOTPA_{(T2)}$	.29**	.36**	.28**	.50**	.33**	.06	.03	.21*	.09	.33**	.43**	.42**	.49**	.68**	1		
16. $WPA_{(T1)}$	-.03	.08	.06	.16	.16	-.02	.04	.16	.09	.07	.11	.05	.71**	.14	.46**	1	
17. $LTPA_{(T1)}$	.26*	.33**	.29**	.46**	.27**	.06	-.00	.16	-.05	.20*	.31**	.32**	.15	.60**	.53**	.09	1
18. $TOTPA_{(T1)}$	.29**	.38**	.31**	.45**	.30**	.05	.1	.17	.01	.25*	.32**	.31**	.40**	.46**	.71**	.45**	.77**

Notes: WPA is workplace physical activity; LTPA is leisure-time physical activity; TOTPA is total physical activity. $_{(T1)}$ denotes Time 1 physical activity measures; $_{(T2)}$ denotes Time 2 physical activity measures; * $p < .05$; ** $p < .001$.

Correlations with background factors

In Ajzen's extended TPB model (Ajzen & Fishbein, 2010; Montaño & Kasprzyk, 2008), factors such as gender, education, health status, family status, past behaviour, etc., are regarded as 'background' variables and are considered time-invariant antecedents or predictors of TPB model. Moreover, as discussed in Chapter 2, literature suggested that physical activity behaviour is associated with several 'background factors', including gender, socio-economic status, general health status, obesity, etc. Relationships with background variables were also inspected using bivariate correlations. Correlations between selected background variables, TPB items and physical activity variables are presented in Annex A.

At baseline, small associations with TPB items and physical activity outcome variables were found in all background factors except in the intervention group variable. This was consistent with the fact that participants were randomly assigned to intervention groups (e-mail only vs. e-mail plus two SMS text messages). Nonetheless, most of the correlations were small in magnitude, with an average absolute correlation $r = .18$, $SD = .07$, range: .09 – .31, calculated across significant associations significant at $p < .05$ and $p < .001$. The average coefficient of determination was also small ($r^2 = .03$, $SD = .03$, range = .01 – .10), indicating that the average shared variance between two correlated variables was 3% (ranging from 1% to 10%). According to the cut-off points identified through the sensitivity power analysis, only few correlations achieved enough power to detect significant relationships between background variables in the given sample. The only background factor that was strongly correlated with TPB items measured at baseline was perceived health status. In particular it was positively associated with attitudes towards physical activity, represented by ATT2 and ATT3 items (Spearman's $\rho = .21$, $p < .001$; $\rho = .24$, $p < .001$), and with perceived behavioural control, in particular with PBC2 item (Spearman's $\rho = .20$, $p < .001$). The positive direction of the relationship indicated that higher levels of perceived health status were associated with higher scores on attitudes and perceived behavioural control scales in the aforementioned TPB indicators.

4.4 Exploring the measurement model

To determine whether the TPB was a good model for predicting behaviour, first the measurement structure and then the structural relationships (between variables) were tested. To assess the measurement structure a confirmatory factor analytic (CFA) approach was used, using limited information approach. CFA is appropriate in theory testing and when an already established measurement instrument has been utilised (Brown, 2006). The measurement model was tested cross-sectionally, at each point in time (baseline, Time 1 and Time 2) and longitudinally, in order to establish measurement invariance and determine whether the latent factor structure could replicate over time and between relevant groups (i.e., intervention group 1 vs. intervention group 2; males vs. females). Measurement model invariance was used to establish whether the model could fit across groups and if it could replicate across three time points. Moreover, CFA was used to provide a wholly comprehensive test of reliability, convergent and discriminant validity and test-retest reliability.

4.4.1 Internal consistency and test-retest reliability

Prior to testing the measurement model with a confirmatory factor analysis framework, the internal consistency and test-retest reliability of the scales measuring TPB direct measures were assessed. Cronbach's alpha coefficients were computed for all items at baseline, Time 1 and Time 2 follow-ups. Internal consistency estimates for each time point are shown in Table 4.13. Behavioural intention presented the highest internal consistency estimates across all three time points (mean = .88, range .85 – .90), followed by attitude (mean = .81, range .79 – .84), and perceived behavioural control (mean = .74, range = .73 – .76). Subjective norm scores presented the lowest internal consistency (mean = .49, range .48 – .52) and Chronbach's alpha below the minimum accepted threshold of .50 at baseline and Time 2. All other values were above the recommended value of .70, suggesting that the items presented acceptable internal consistency.

Table 4.13. Cross-sectional internal consistency estimates of TPB construct direct measures at baseline, Time 1 and Time 2 follow-ups

Construct	Nr. of items	Cronbach's Alpha		
		Baseline n = 393	Time 1 n = 162	Time 2 n = 140
Attitude	3	.80	.79	.84
Subjective norm	3	.48	.52	.48
Perceived behavioural control	3	.74	.76	.73
Behavioural intention	3	.85	.90	.89

In addition to Chronbach's alpha estimates, corrected item-total correlations (CITC) of single indicators at each time point were inspected to see whether the indicators were highly and positively correlated with each other at each time-point. Item-total correlations refer to correlations of an item with the composite score of all the items measuring the same construct. Corrected item-total correlation (CITC) is the correlation between a composite score, which is calculated by excluding the item in question, and the item itself, so that it is labelled 'corrected' (Lu, Lai, & Cheng, 2007, p. 855). Some authors recommended that corrected item-total correlations should range between .30 and .70 (Ferketich, 1991), some others suggest using a traditional cut-off point of .50 (Fen & Sabaruddin, 2009; Lu et al., 2007).

Overall, attitude and behavioural intention did not have CITCs below .50. All three subjective norm items and perceived behavioural control PBC3 item did not show good internal consistency and reliability at baseline, Time 1 and Time 2 follow-ups (see Table 4.15). In particular, SN1 and SN3 presented CITCs below the traditional cut-off point at all three time-points. If a conservative approach was used, all three subjective norm items and PBC3 item should have been dropped from further analysis and should not be used in creating composite scores of their respective TPB constructs.

Table 4.14. Corrected Item-total Correlations (CITC) for the TPB constructs at each point in time

Construct		Items	Baseline n = 393	Time1 n = 162	Time2 n = 140
Attitude	ATT1	For me, to […] would be: unimportant/important	.58	.56	.64
	ATT2	For me, to […] would be: not enjoyable/enjoyable	.68	.71	.78
	ATT3	For me, to […] would be: exhausting/energising	.66	.64	.71
Subjective norm	SN1	Most people who are important to me think that I should not / I should […]	.33	.33	.18
	SN2	It is expected of me that I […]	.33	.40	.41
	SN3	I feel under social pressure to […]	.24	.29	.33
Perceived Behavioural control	PBC1	I am confident that I can […]	.58	.68	.65
	PBC2	For me it would be very difficult / very easy to […]	.66	.67	.68
	PBC3	The decision to […] is beyond my control	.46	.45	.36
Behavioural intention	INT1	I want to […]	.61	.69	.67
	INT2	I intend to […]	.79	.89	.86
	INT3	I expect to […]	.77	.88	.85
Total number of items = 12					

Notes: For reasons of space and for simplicity, in the table the behavioural focus "get at least 30 minutes of moderate physical activity on at least 5 days or 20 minutes of vigorous physical activity on at least 3 days this coming week" is replaced with […].

Test-retest reliability was also estimated by examining correlations between pre- and post-test measures and intra-class correlations (ICC) coefficients, as shown in Table 4.15. The average intra-class correlation coefficients for attitude construct ranged from .79 to .87, for subjective norms from .64 and .74, for perceived behavioural control from .71 to .83, and for behavioural intention from .77 to .81. These findings suggest that the reliability of the items was stable at each time point. These results are based on a complete-case analysis. Power calculations with G*Power suggested overall sufficient power (larger than .90) for all bivariate correlations, even when inter-item correlations were as little as .31 (i.e., in subjective norms items SN1 and SN3)[15].

[15] With SN1 item, the protocol of achieved power indicated a power of .95, based on one-tailed correlation of .31, alpha level of .05, and sample size of 103. When two-tailed correlation was inputted, the achieved power was .90.

Table 4.15. Correlations and intra-class correlations of TPB direct measure items

	Baseline		Time 1		Time 2		Correlations			ICC	
Items	M	SD	M	SD	M	SD	BL - T1	BL - T2	T1 - T2	item	average
Attitude											
ATT1	5.32	1.46	5.23	1.55	5.52	1.43	.65**	.64**	.67**	.65	.85
ATT2	5.04	1.44	5.08	1.51	5.20	1.50	.67**	.66**	.76**	.70	.87
ATT3	4.77	1.48	5.10	1.43	5.19	1.37	.57**	.47**	.64**	.56	.79
Subjective norm											
SN1	5.32	1.16	5.10	1.35	5.06	1.13	.31**	.32**	.50**	.37	.64
SN2	3.38	1.86	3.56	1.71	4.08	1.62	.43**	.45**	.51**	.46	.72
SN3	2.40	1.56	2.59	1.56	2.75	1.60	.50**	.45**	.50**	.48	.74
PBC											
PBC1	4.45	1.82	4.34	1.94	4.43	1.91	.58**	.61**	.69**	.63	.83
PBC2	3.84	1.53	3.83	1.72	3.95	1.65	.41**	.38**	.54**	.45	.71
PBC3	5.05	1.66	4.60	1.85	4.47	1.86	.47**	.52**	.43**	.47	.72
Behavioural intention											
INT1	5.90	1.24	5.59	1.50	5.65	1.48	.51**	.55**	.54**	.53	.77
INT2	5.20	1.53	4.84	1.80	5.11	1.70	.47**	.60**	.63**	.57	.77
INT3	5.23	1.52	4.83	1.79	5.23	1.68	.60**	.46**	.68**	.58	.81

Notes: Correlations were based on complete-case analysis (n = 103). All items ranged from 1 to 7. For reasons of space and for simplicity, in the table the behavioural focus "get at least 30 minutes of moderate physical activity on at least 5 days or 20 minutes of vigorous physical activity on at least 3 days this coming week" is replaced with […]; ** p < .001 (two-tailed)

4.4.2 Longitudinal measurement invariance

An alternative strategy to assess test-retest reliability and stability of measurement over time involved the use of a confirmatory factor analytic approach testing longitudinal measurement invariance. This approach allowed examining whether the same latent factors were measured the same way over time (from baseline to Time 1 and Time 2) with the full sample of participants used for longitudinal comparisons (n = 361). According to Brown (2006), longitudinal measurement invariance is a fundamental aspect for evaluating temporal change (or stability) in a construct and it is a recommended approach that should precede applications of SEM procedures with longitudinal data, such as latent growth curve models, or autoregressive/cross-lagged panel models (Brown, 2006). Longitudinal measurement invariance is an important step in evaluating change over time because "in the absence of such evaluation, it cannot be determined whether temporal change observed in a construct is due to true change in the structure or measurement of the construct over time" (Brown, 2006, pp. 252–253). Chan (1998) identified three types of change that might occur when in repeated measurements: alpha, beta and gamma change. Alpha indicates a true score change or invariance when the measurement of the construct does not change over time. Beta change occurs when the construct remains constant, but the measurement properties of the indicators (i.e., observed endogenous variables) are temporally inconsistent, for example when scales across various assessments are not the same. Gamma change occurs when the meaning of the construct changes over time, when the numbers of factors representing the construct vary across assessments. From Chan's perspective, longitudinal measurement invariance truly occurs when beta and gamma changes are absent (Chan, 1998). If measurement varies over time, "it is misleading to analyse and interpret the temporal change in observed measures or latent constructs; change might be misinterpreted as alpha change when in fact the precision of measurement of the construct or the construct itself varies across time" (Brown, 2006, p. 253).

The procedure of longitudinal measurement invariance was used and reported in various SEM studies (e.g., Cheung & Rensvold, 2002; Gregorich, 2006; Motl, McAuley, & Mullen, 2011; Randall & Engelhard, 2010; Widaman, Ferrer, & Conger, 2010) and it involves the estimation of progressively more constrained nested models, which correspond to the four primary forms of measurement invariance: configural, metric, scalar, strong factorial, and strict factorial invariance (Vandenberg & Lance, 2000; Widaman et al., 2010), or, in Brown's (2006) terms, equal form, equal factor loadings, equal intercepts, and equal residual variances.

Equal form (also referred to as 'configural invariance') is based on the assumption that the same number of common latent factors, with an identical number and pattern of items and factor loadings, is assessed over time (i.e., test gamma change). Equal factor loadings invariance (or 'metric invariance') requires that factor loadings across the same items are invariant over time. Equal intercepts invariance (or 'scalar invariance') is based on the assumption that item intercepts, as well as factor loadings, do not change over time. When evidence supports also the invariance of item intercepts over time, analysis of mean change would indicate a change over time that could be attributed to true change in the constructs (Brown, 2006). Lastly, equal residual invariance (or ‘strict factorial invariance’) tests the equivalence of the indicators’ residual variances (i.e., the amount of variance explained by the error term), holding constant factor loadings, item intercepts and item residual variances. Some authors reported also more stringent tests for ‘strict factorial invariance’, which consists of imposing equality constraints in factor variances and factor means (e.g., Motl et al., 2011). However, some methodologists acknowledged that such constraints would rarely hold in realistic datasets and equal indicator residual variances is not considered as important to the evaluation of measurement as the tests for equal form, equal factor loadings and equal intercepts (Brown, 2006; Chan, 1998). Therefore, for the scope of this dissertation, only these four types of measurement invariance were tested.

The common procedure to test for the four forms of measurement invariance involves a comparison of the models using a series of Chi-square difference tests. The starting point is establishing equal form invariance. This is achieved when the fully unconstrained model achieves a good fit, as indicated by the global fit indices. Model fit was assessed using the goodness of fit criteria outlined in Chapter Three. If the model achieves a good fit, then the structure could be said invariant over time. Second comes the test for equal factor loadings (i.e., ‘metric invariance’ or ‘weak factorial invariance’), which is implemented by setting the factor loadings to be equal over time. If the Chi-square difference test between equal form model and the nested equal factor loading model is non-significant, then data support the evidence for metric invariance. The third step is testing for equal item intercepts (i.e., ‘scalar invariance’). If the Chi-square difference test between the equal factor loadings and equal intercepts nested model is non-significant, scalar invariance is achieved. The fourth step is to test for equal residual variances (i.e., ‘strong factorial invariance’). The Chi-square of the final model is compared to the previous model of equal item intercepts, and if the difference is non-significant, then it can be concluded that also residual variances are invariant over time.

The longitudinal measurement invariance procedure presented in this paragraph included tests for equal form (configural), equal factor loadings (metric), equal indicator intercepts (scalar), and equal indicator error variances (strong factorial) over time (Brown, 2006). A graphical representation of the model tested for attitudes is shown in Figure 4.1. The model included three correlated latent factors, depicted as ellipses, which correspond to the baseline, Time 1 and Time 2 measurement occasions. The three items per factor (ATT1, ATT2 and ATT3), represented as rectangles, were forced to load only on the common factor in their respective measurement occasion. The error terms which are represented by a circle, were allowed to correlate with the error terms of the same items (e.g., e1 with e4 and e7). In the equal form model (Model 1), the factor loading of the first item in each common latent factor was fixed to 1.0 to set its scale, and the intercept of its corresponding item was fixed to 0 for the purpose of model identification. The remaining factor loadings, intercepts, residual variances and factor variances and covariances were freed and allowed to be estimated. If Model 1 achieved good fit, then the common factor for attitude generalised over time, which means that the measured factor achieved configural invariance.

The subsequent models built upon Model 1 by setting more stringent constraints. In Model 2 (equal factor loadings) the factor loadings for the same items were set to be equal, in order to test whether they were invariant over time (i.e., metric invariance). If Model 2 achieved an acceptable model fit compared to Model 1 and if the Chi-square difference was non-significant, then data supported the evidence for metric invariance, so factor loadings were invariant over time. In Model 3 (equal indicator intercepts), factor loadings and intercepts for the same items were set to be equal over time: an acceptable fit of Model 3 supported the assumption of scalar invariance over time. In Model 4 (equal indicator error variances) the residual variances, together with factor loadings and item intercepts, were set equal in each item. If the model achieved an acceptable fit, it could be concluded that item reliability was invariant over time.

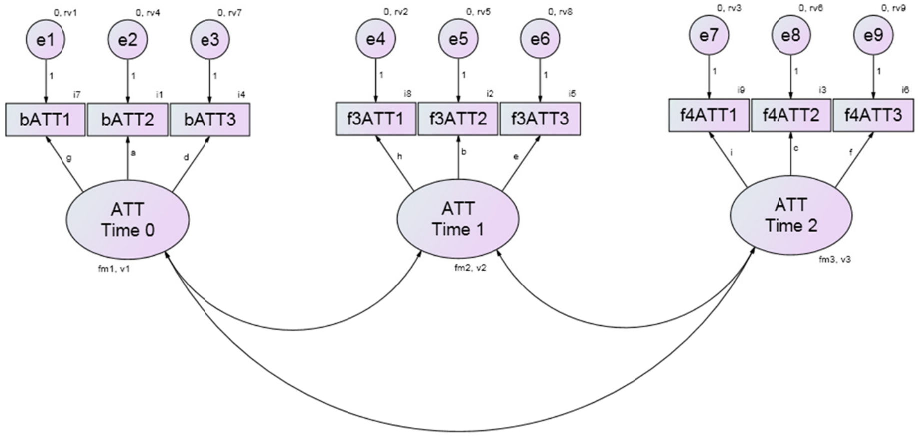

Figure 4.1. CFA Model testing longitudinal measurement invariance for attitude

Models were estimated using a robust maximum likelihood (MLR) estimator as implemented in Mplus v6.12. The Chi-square difference was corrected using the Satorra-Bentler (2001) scaled Chi-Square, which is robust to violations of normality. The differences between the scaled Chi-square estimates were calculated using the formulas indicated by Satorra and published on Mplus' website (Muthén & Muthén, n.d.). The Chi-square difference test was coupled with the evaluation of changes in the comparative fit index (CFI), calculated by subtracting the estimated CFI of the more stringent model from the CFI of the less constrained model. The ΔCFI measure should be below –.01 (Cheung & Rensvold, 2002; Vandenberg & Lance, 2000). A limited information approach was used to assess measurement invariance on each TPB construct separately in order to determine whether the measurement structure of each latent factor was invariant over time. Models were estimated first with the full sample for longitudinal comparisons (n = 361), and then with a sample which did not include multivariate outliers (n = 355), to test whether their presence could bias the estimates. Results did not differ in terms of Chi-square difference tests and ΔCFI; hence the small presence of multivariate outliers was compensated by the larger sample, so that the effect of outliers could be safely ignored. The following results are based on the test with the full sample (n = 361). Missing data were dealt with full-information maximum likelihood (FIML) algorithm.

4.4.2.1 Equal form (configural invariance)

The fit statistics and Chi-square differences are shown in Table 4.16. Data provided evidence of configural invariance over a 16 week period for all variables. In fact, the equal form models of all TPB constructs showed evidence of configural invariance, as demonstrated by the fact that all global model fit indices pointed towards a good model fit: attitude (χ^2 = 20.569, df = 15, p = 0.151; RMSEA = .032, 90% CI: .000 to .063; PCLOSE = .803; SRMR = .039; CFI = .990); perceived behavioural control (χ^2 = 9.656, df = 15, p = .841; RMSEA = .000, 90% CI: .000 to .029; PCLOSE = .996; SRMR = .027; CFI = 1.000); subjective norms (χ^2 = 16.226, df = 15, p = .367; RMSEA = .000, 90% CI: .000 to .053; PCLOSE = .929; SRMR = .044; CFI = .995); and behavioural intention (χ^2 = 23.706, df = 15, p = .070; RMSEA = .040, 90% CI: .000 to .069; PCLOSE = .676; SRMR = .038; CFI = .988). This indicated that the structure of the common latent factors representing attitudes, subjective norms, perceived behavioural control, and behavioural intention generalised over time and across a period of 16 weeks (from baseline to Time 2 follow-up).

4.4.2.2 Equal factor loadings (metric invariance)

After having established form (configural) invariance of the TPB latent factors, the test for equal factor loadings (metric invariance) could be undertaken. Non-significant Chi-square difference tests and minimal differences in CFI (all ΔCFI values $\leq$ .01) between Model 1 (equal form) and Model 2 (equal factor loadings) showed also that factor loadings of the items used to assess attitudes, perceived behavioural control, subjective norms, and behavioural intention latent factors were invariant over time.

On the basis of these results, it could be concluded that the indicators evidenced equivalent relationships to the respective latent constructs over time. The standardised factor loadings estimated with the most stringent and valid model across all TPB latent factors (i.e., equal factor loadings) are presented in Table 4.17. Data showed that some items presented low factor loadings and were associated with low reliability estimates (i.e., high item error variances) in all time points. For example, ATT1 item, even if the mean factor loading was moderately high .63 (range = .60 – .67), showed values of reliability estimates below .50. Generally, for developing reliable measurement instruments, it is recommended to use indicators with good psychometric characteristics, that is, with relatively high standardised factor loadings: some authors suggest that they should be larger than .60 (Kline, 2005, p. 178), some others suggest they should range between .50 and .70 (Hair, Black, Babin, & Anderson, 2010).

If indicators have standardised regression weights smaller than .50, it means that they are not aligned with the latent factors, whereas above .50 they provide evidence of acceptable reliability (Bollen, 1989). Low factor loadings were found also in PBC3 item, with a mean factor loading of .53 (range = .51 – .56) and a mean item reliability of .28 (range = .26 – .31) over three time points. Other low factor loadings were found in SN1 and SN3 items, with mean item reliabilities of .26 (range = .24 – .27) and .16 (range = .14 – .18) respectively; and in INT1 item, with a mean factor loading of .70, but .49 but a mean item reliability of .49 (range = .45 – .54), which was the lowest among the other items measuring behavioural intention. These results suggested that ATT1, PBC3, SN1, SN3 and INT1 items did not load appropriately on their respective latent factors and posed problems in terms of reliability.

Table 4.16. Chi-square tests for longitudinal invariance of the TPB latent factors over three points in time (12 and 16 weeks)

Model	χ^2	df	CFI	$\Delta\chi^2$	Δdf	ΔCFI	RMSEA (90% CI)	CFit	SRMR
Attitude									
1. Equal form	20.57	15	.99				.032 (.000 - .063)	.803	.039
2. Equal factor loadings	23.69	19	.99	3.05	4	.00	.026 (.000 - .056)	.898	.042
3. Equal item intercepts	31.20	23	.99	7.78	4	-.01	.031 (.000 - .057)	.872	.047
4. Equal error variances	49.21	29	.96	15.34*	6	-.02	.044 (.021 - .021)	.065	.095
Perceived behavioural control									
1. Equal form	9.66	15	1.00				.000 (.000 - .029)	.996	.027
2. Equal factor loadings	13.87	19	1.00	4.24	4	.00	.000 (.000 - .029)	.031	.043
3. Equal item intercepts	37.32	23	.97	23.64**	4	-.03	.042 (.013 - .065)	.696	.049
4. Equal error variances	48.85	29	.96	11.43	6	-.01	.044 (.02 - .064)	.671	.068
Subjective norm									
1. Equal form	16.23	15	1.00				.015 (.000 - .053)	.929	.044
2. Equal factor loadings	24.76	19	.98	8.25	4	-.02	.029 (.000 - .058)	.873	.061
3. Equal item intercepts	44.95	23	.92	24.06**	4	-.06	.051 (.028 - .074)	.428	.066
4. Equal error variances	52.76	29	.91	7.10	6	-.01	.048 (.026 - .068)	.548	.075
Behavioural intention									
1. Equal form	23.71	15	.99				.040 (.000 - .069)	.676	.038
2. Equal factor loadings	25.59	19	.99	1.49	4	.00	.031 (.000 - .059)	.850	.042
3. Equal item intercepts	30.24	23	.99	4.47	4	.00	.030 (.000 - .056)	.893	.044
4. Equal error variances	58.04	29	.96	22.19*	6	-.03	.053 (.033 - .072)	.386	.069

Notes: $\Delta\chi2$ = nested Chi-square difference between models; Δdf = difference in degrees of freedom between nested models; ΔCFI = difference in CFI between nested models; RMSEA = root mean square error for approximation; 90% CI = confidence interval for the RMSEA; CFit = test for close fit (PCLOSE), i.e., the probability for the RMSEA to be $\leq$ .05; SRMR = standardised root mean square residual. Estimates were calculated using the robust maximum likelihood estimator (MLR) as implemented in Mplus (Muthén & Muthén, 2011). The chi-square difference test is scaled based on the formula initially provided by Satorra (2000).
* $p < .05$; ** $p < .001$.

Table 4.17. Standardised factor loadings and item reliability estimates for each TPB latent factor across three time points (16 weeks)

Factors / Items	Baseline		Time 1		Time 2	
	Standard. loading	Item reliability	Standard. loading	Item reliability	Standard. loading	Item reliability
Attitude						
ATT1	.62	.39	.60	.36	.67	.46
ATT2	.87	.75	.89	.80	.91	.83
ATT3	.74	.55	.76	.58	.83	.69
Perceived behavioural control						
PBC1	.72	.52	.79	.62	.79	.62
PBC2	.87	.76	.89	.79	.93	.86
PBC3	.52	.27	.56	.31	.51	.26
Subjective norm						
SN1	.51	.26	.52	.27	.49	.24
SN2	.63	.40	.71	.50	.66	.44
SN3	.38	.14	.42	.18	.38	.15
Behavioural intention						
INT1	.67	.45	.73	.54	.70	.49
INT2	.88	.77	.98	.96	.94	.89
INT3	.88	.77	.95	.91	.93	.87

Notes: All estimates are significant at $p < .001$. Estimates are calculated using the sample $n = 361$ with FIML to deal with missing data; results based on the equal factor loadings for all factors. Item reliability estimates are calculated as difference between 1 and item residual variance.

4.4.2.3 Equal item intercepts (scalar invariance)

Keeping the constraints on factor loadings in place (Model 2), the next nested model (Model 3) imposed an additional constraint by fixing the item intercepts of like items equal across time, except for the first indicators, whose intercepts were fixed to zero for the purposes of model identification. These further restrictions did not lead to a significant reduction in model fit of the models involving attitudes and behavioural intention latent factors. In fact, the Chi-square difference tests with the equal factor loadings model (Model 2) were non-significant (see Table 4.16). These results were consistent with those reported in the literature about temporal stability of attitudes (e.g., Ajzen & Fishbein, 2010) and behavioural intentions (e.g., Rhodes et al., 2010; Sheeran

& Abraham, 2003; Sheeran, Orbell, & Trafimow, 1999), since the means of the items (i.e., item intercepts) utilised for assessing these two constructs were stable over time. These results suggested also that an analysis of mean change over time of the observed items could be attributable to a true change in the construct, since the mean of the indicator is related to the mean of the latent factor and the factor loading (see Brown, 2006, p. 257).

For perceived behavioural control and subjective norms, data did not support the evidence for scalar invariance for item intercepts ($\Delta\chi^2 < .05$; $\Delta CFI > -.01$), suggesting that the location of some parameters of these two latent factors changed over time. For example, it could be due to a spurious shift from a portion of the SN2 item scale at Time 1 to another portion of the response scale at Time 2, as it might occur in cases of leniency bias (Brown, 2006; Vandenberg & Lance, 2000). Leniency bias is defined as the tendency of respondents to overestimate a measure, assuming that each respondent source is previously exposed to the same sets of items (Vandenberg & Lance, 2000). This might have happened in this case, as people responded to the same set of questions over three time points and could have shifted the scoring of subjective norms and perceived behavioural control items.

Because the hypothesised models of equal item intercepts for perceived behavioural control and subjective norms were not valid, a test for equal item error variances could not be considered valid, even if the fit of Model 4 was not significantly different from the hypothesised Model 3. An alternative approach was applied to solve the issue of non-invariance in item intercepts for these two latent constructs and is described in the following paragraph.

4.4.2.4 Partial invariance for PBC and subjective norms

As previously noted, the results of the tests for item intercepts invariance perceived for behavioural control and subjective norms did not support the evidence for scalar invariance. To detect which items changed over time, a partial measurement invariance approach was used (as described in: Brown, 2006, pp. 299 – 302). Partial measurement invariance consists of relaxing some constraints in the models that did not achieve good fit, so that they could be freely estimated. The freely estimated parameters, if they are aligned with the measurement structure, should improve the model fit, otherwise the model fit will not be improved. Therefore, the more unconstrained model with equal intercepts (minus one) was re-fitted to the data and compared to the valid equal factor loadings model (Model 2). Since the item intercept of the first item (the so called ‘marker variable’, with factor loading fixed to 1.0) was set to zero for the purpose of model identification, partial measurement invariance was explored by giving each item in turn the status of marker variable and constraining the other two item one at a time, in order to isolate the source or the sources of variation in item intercepts. For example, in one model, SN1 item was used as marker variable (i.e., factor loading fixed to 1.0 and intercept fixed to zero for model identification).

Considering that one item is always fixed (as marker variable) and the other two items can have two possible conditions (free or constrained), a combination of six models is possible. However, it has to be noted that the condition of being a marker variable means not only that the factor loading is fixed to 1, but also that the item intercept is constrained, because is equal to zero. Therefore, three out of six combinations mentioned above are equivalent. In the example before, the model with SN1 item marker variable, SN2 unconstrained, and SN3 constrained, is equivalent to SN3 marker variable, SN2 unconstrained, and SN1 constrained. All possible combinations were tested to ensure that the computations were correct, but results are reported only for the models with a unique combination of the three items. Estimates and Chi-square difference tests of all the models are reported in Table 4.18 below.

Perceived behavioural control

For perceived behavioural control, the model with PBC1 used as marker variable, PBC2 item intercept constrained and PBC3 item intercept freely estimated (Model 3a) achieved a good model fit (χ^2 = 13.967, df = 21, p = .871; RMSEA = .000, 90% CI: .000 to .023; PCLOSE = .999; CFI = 1.000; SRMR = .043); the scaled Chi-square difference test with the equal factor loadings model (Model 2) became non-significant, showing that partial invariance of item intercepts was achieved. The model with PBC2 item intercept unconstrained, PBC1 marker variable, and PBC3 item intercept constrained (Model 3b), and the model with PBC1 item intercept unconstrained, PBC2 marker variable, PBC3 item intercept constrained (Model 3c) lead to a significant reduction in model fit, $\Delta\chi^2 = 20.33$, $\Delta df = 2$, $p < .001$, $\Delta CFI = -.02$, and $\Delta\chi^2 = 22.94$, $\Delta df = 2$, $p < .001$, $\Delta CFI = -.03$, respectively, suggesting that item intercepts in these two models changed over time. Only the models with PBC3 freely estimated achieved better fit than the others with PBC3 constrained to be equal over time. However, inspecting modification indices revealed that the model could be improved by adding covariances between PBC3 item and the latent factors or between PBC3 items.

These results suggested that PBC3 item was a possible source of variability in item intercepts, because when the constraints on this item were released, item intercepts were allowed to vary across time, and the model fit improved; conversely, when equality constraints were imposed on PBC3 item intercept, the model did not achieve a good fit. This was reflected on the fact that PBC3 item presented lower factor loadings than the other items measuring perceived behavioural control latent factor presented in the previous paragraph (Table 4.17). This was consistent with test-retest reliability results, showing that PBC3 item presented internal consistency issues.

Subjective norm

The same procedure described above for perceived behavioural control model was replicated for subjective norms model. Good model fit and a non-significant difference with the reference Model 2 (equal factor loadings) was achieved in the following models: Model 3h, with SN2 item intercept unconstrained, SN1 marker variable and SN3 item intercept constrained (equivalent to: SN2 unconstrained, SN3 marker, SN1, constrained): $\Delta\chi^2 = 4.15$, $\Delta df = 2$, $p = .126$, $\Delta CFI = -.01$; Model 3i, with SN1 item intercept unconstrained, SN2 marker variable, and SN3 item intercept constrained (equivalent to: SN1 unconstrained, SN3 marker variable, SN2 constrained): $\Delta\chi^2 = 1.25$, Δdf = 2, p = .535, ΔCFI = .00. The model with SN3 item intercept unconstrained, SN1 marker variable and SN2 item intercept constrained (Model 3g) did not achieve a significant improvement, and the Chi-square difference with Model 2 was highly significant ($\Delta\chi^2$ = 38.71, Δdf = 2, p < .001, ΔCFI = -.07). When SN3 was freely estimated, the model fit did not significantly improve, but modification indices suggested adding correlations between SN2 and SN1 factors. Inspecting the factor loadings (see Table 4.17) of subjective norms latent construct revealed that SN1 and SN3 items had low item reliability compared to SN2. In general, all subjective norm items presented some critical points.

Table 4.18. Comparisons between equal factor loadings and equal item intercepts models for Perceived behavioural control and Subjective norms (n = 361)

Models	χ^2	df	CFI	$\Delta\chi^2$	Δdf	ΔCFI	RMSEA (90% CI)	CFit	SRMR
Perceived behavioural control									
2. Equal factor loadings	13.869	19	1.000				.000 (.000 - .029)	.031	.043
3a. Equal item intercepts	13.967	21	1.000	0.09	2	.00	.000 (.000 - .023)	.999	.043
3b. Equal item intercepts	33.493	21	0.978	20.33**	2	-.02	.041 (.008 - .065)	.706	.046
3c. Equal item intercepts	36.61	21	0.972	22.94**	2	-.03	.045 (.018 - .069)	.592	.049
Subjective norm									
2. Equal factor loadings	24.755	19	0.978				.029 (.000 - .058)	.873	.061
3g. Equal item intercepts	44.663	21	0.909	38.71**	2	-.07	.056 (.033 - .079)	.079	.065
3h. Equal item intercepts	28.948	21	0.970	4.15	2	-.01	.032 (.000 - .059)	.848	.064
3i. Equal item intercepts	26.019	21	0.981	1.25	2	.00	.026 (.000 - .054)	.914	.064

Notes: $\Delta\chi2$ = nested Chi-square difference between models; Δdf = difference in degrees of freedom between nested models; ΔCFI = difference in CFI between nested models; RMSEA = root mean square error for approximation; 90% CI = confidence interval for the RMSEA; CFit = test for close fit (PCLOSE), i.e., the probability for the RMSEA to be ≤ .05; SRMR = standardised root mean square residual.
Model 3a: PBC3 unconstrained (u), PBC1 marker variable (mv), PBC2 constrained (c), equivalent to: PBC3 u, PBC2 mv, PBC1 c); Model 3b: PBC2 u, PBC1 mv, PBC3 c, equivalent to: PBC2 u, PBC3 mv, PBC1 c; Model 3c: PBC1 u, PBC2 mv, PBC3 c, equivalent to: PBC1 u, PBC3 mv, PBC2 c; Model 3g: SN3 u, SN1 mv, SN2 c, equivalent to: SN3 u, SN2 mv, SN1 c; Model 3h: SN2 u, SN1 mv, SN3 c, equivalent to: SN2 u, SN3 mv, SN1 c; Model 3i: SN1 u, SN2 mv, SN3 c, equivalent to: SN1 u, SN3 mv, SN2 c.
** p < .001.

4.4.2.5 Equal error variances (strong factorial invariance)

Keeping the equality constraints in factor loadings, and item intercepts in place, the fourth level of measurement invariance was tested by imposing equality constraints across error variances of like items over time. If the Chi-square difference test between Model 4 (equal error variances) and Model 3 (equal item intercepts) was non-significant, then data supported the evidence for strong factorial invariance. In other terms, the residual variances in like items were not invariant over time, indicating a form of stability in the reliability of these measures.

Evidence for equal item error invariance was not found in the models involving attitudes ($\Delta\chi^2 = 15.34$, $\Delta df = 6$, $p < .05$, $\Delta CFI = -.02$) and behavioural intention ($\Delta\chi^2 = 22.19$, $\Delta df = 6$, $p < .05$, $\Delta CFI = -.03$), indicating that residual variances of the items measuring these two constructs varied over time. Nevertheless, the lack of equality in residual variances was not considered an important issue, because, as noted by Brown, "heterogeneity of variance is a common outcome in repeated measures designs and the test of equal residual variances often fails because of the temporal fan spread of indicator variances" (Brown, 2006, p. 266). A change in residual variances might be interpreted as individual differences in response, due to an intervention aimed at changing those constructs, or by many other factors, also considering the time lag between assessments. As equal item error invariance test is not regarded as important to the evaluation of measurement as the previously described models (Brown, 2006; Chan, 1998), it was not considered a fundamental problem. For the scope of this dissertation, potential differences in the items were considered part of the test of the intervention effects, which will be discussed in the following paragraphs.

For perceived behavioural control, the only model that achieved good fit in the test for partial intercept invariance (Model 3a) was used as starting point for testing for error invariance (Model 4a). Model 4a achieved a good fit ($\chi^2 = 23.879$, $df = 27$, $p = .637$; RMSEA = .000, 90% CI: .000 to .035, PCLOSE = .996; CFI = .996; SRMR = .049) and the additional constraint did not result in a significant decrease in model fit from the comparison model: $\Delta\chi^2 = 9.679$, $\Delta df = 6$, $p = .139$, $\Delta CFI = .00$. These results suggest that, when PBC3 item intercept was released, and PBC2 was marker variable and PBC1 were constrained to equal, the item error variances were found to be invariant over time. In addition, fit diagnostics revealed that PBC3 was associated with standardised residual covariances larger than 2, which indicate potential problems in the item. Moreover, residual variances were varying over time: at baseline they were larger than 2.0 and then decreased significantly in the other two time points.

For subjective norms, the models tested for error invariance were two (Model 4h, and Model 4i), because both supported the evidence for item intercept invariance. Model 4h, with SN2 item intercept unconstrained, SN1 marker variable and SN3 item intercept constrained, and residual variances constrained to be equal across the three time points, achieved overall a good fit ($\chi^2 = 35.605$, df = 27, p = .124; RMSEA = .030, 90% CI: .000 to .054, PCLOSE = .911; CFI = .967; SRMR = .077). The restrictions imposed on item error variances did not translate into a decrease in model fit: $\Delta\chi^2 = 6.371$, Δdf = 6, p = .339, ΔCFI = .00, indicating that the error variance of the model was temporally invariant. Similarly, Model 4i, with SN1 item intercept unconstrained, SN2 marker variable, SN3 item intercept constrained, and residual variances constrained, the model achieved a good fit ($\chi^2 = 32.923$, df = 27, p = .200; RMSEA = .025, 90% CI: .021 to .050, PCLOSE = .948; CFI = .977; SRMR = .074), and resulted in a non-significant decrease in model fit from Model 3: $\Delta\chi^2 = 6.804$, Δdf = 6, p = .339, ΔCFI = .00, indicating that the error variances in each indicator were temporally invariant. However, inspecting fit diagnostics and standardised residual variances, showed that in both model SN3 residual variances were larger than 2.5, indicating a possible source for bad fit. However, these were compensated by the fact that the item intercept of SN3 was constrained.

4.4.3 Cross-sectional CFA of the full TPB measurement model

In addition to traditional internal consistency and reliability tests, and to further investigate the issues of reliability raised in the previous paragraph, a confirmatory factor analysis approach was used to simultaneously assess measurement reliability, internal consistency, convergent and discriminant validity of the full TPB measurement model from a cross-sectional point of view. Within a confirmatory factor analytic approach reliability analyses are conducted by confronting the standardised regression weights (factor loadings) of single items, as they provide additional information about the strength of factor loadings and reliability for each indicator. This approach has been used in other studies (Fen & Sabaruddin, 2009; Lu et al., 2007) and it is recommended to establish a good measurement model before testing structural relationships among variables (Brown, 200; Kline, 2005).

To establish validity and reliability in confirmatory factor analysis, the following measures are usually utilised: for reliability, in addition to Chronbach's alpha, Composite Reliability (CR); for establishing convergent validity, the Average Variance Extracted (AVE); for discriminant validity, Maximum Shared Squared Variance (MSV), and Average Shared Squared Variance (ASV). The thresholds for these values are: CR > .70; AVE > .50 and CR > AVE; MSV < AVE and ASV < AVE (Hair et al., 2010, as reported in: Gaskin, 2011).

To assess convergent and discriminant validity, the hypothesised measurement model (depicted in Figure 4.2 below) was fitted to the data cross-sectionally at baseline, Time 1 and Time 2, in order to have an approximate idea of whether the results could replicate over time, and longitudinally (longitudinal measurement invariance). Model fit was assessed using the goodness of fit criteria outlined in Chapter Three. The model fit improvements were made using a conservative strategy, which implies that no cross-loadings between factors and no covariances between error terms were allowed, as these indicate lack of construct validity (Hair et al., 2010).

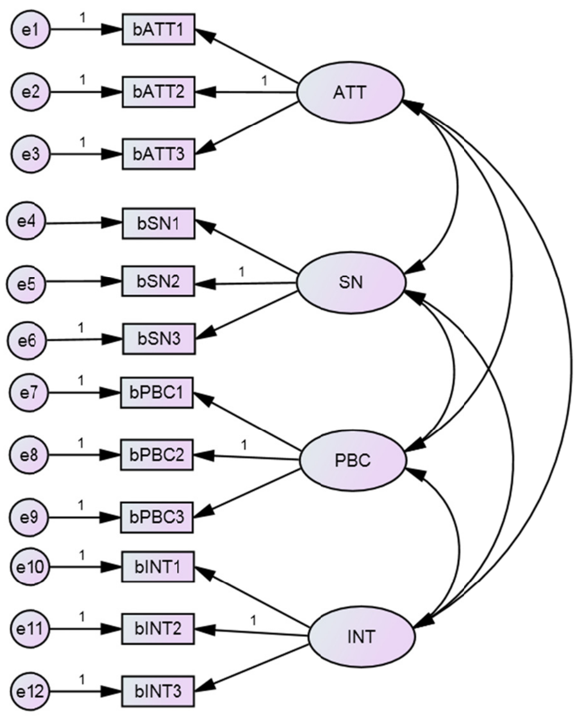

Figure 4.2. Hypothesized measurement model (with baseline items)

Figure 4.2 shows a representation of a confirmatory factor analytic model (the drawing was produced with AMOS). Ellipses represent latent factors (i.e., unobserved endogenous variables). Rectangles represent items (i.e., observed endogenous variables). Circles represent error terms or residuals (i.e., unobserved exogenous variables), which correspond to the measurement error associated with each single indicator. The arrows from latent factors represent factor loadings related to each indicator, and double-headed arrows represent correlations between factors or items. In order for the model to be identified, the factor loading of one item in each latent factor is fixed to 1.0 (as marker item), and the paths from error variances to items are also fixed to 1.0. All other indicators (i.e., residual variances, item intercepts, factor variances, covariances and means, and the factor loadings of the other items) are freely estimated.

4.4.3.1 Baseline measurement model

The baseline hypothesized measurement model represented in Figure 4.2 did not achieve a good fit with the data, as indicated by the global model fit indices: the Chi-square test was significant ($\chi^2 = 214.778$, df = 48, $p < .001$), the Standardized RMR was larger than .05 (SRMR = .073), the RMSEA pointed towards an unacceptable model fit (RMSEA = .097, 90% CI: .084 to .111), the p value for close fit was significant (PCLOSE < .001), and the comparative fit index was smaller than .95 (CFI = .905).

In line with the findings reported in paragraph 4.4.2 about measurement invariance, the initially tested measurement model showed some limitations with regards to convergent and discriminant validity (see Table 4.19). Regarding convergent validity, PBC and subjective norms showed AVE values smaller than .50, which is considered a minimum accepted threshold for validity (Hair et al., 2010). Subjective norms factor had an overall composite reliability score below the accepted threshold of .70. These results suggested that some items were not loading on the expected latent factors. For discriminant validity, the Maximum Shared Squared Variance (MSV) was larger than AVE for behavioural intention and PBC; the Average Shared Squared Variance was below the value of the AVE for all factors, indicating some issues in discriminant validity for the aforementioned latent factors.

Table 4.19. Composite reliability, convergent and discriminant validity estimates for the baseline model (n = 368)

Factors	CR	AVE	MSV	ASV	1	2	3	4
1. Behavioural intention	.854	.664	.667	.436	**.815**			
2. Attitude	.797	.568	.338	.238	.581	.754		
3. Perceived behavioural control	.740	**.498**	.667	.374	.817	.517	**.705**	
4. Subjective norm	**.526**	**.327**	.303	.200	.550	.331	.432	.571

Notes: CR is Composite Reliability; AVE is the Average Variance Extracted; MSV is Maximum Shared Squared Variance, and ASV is Average Shared Squared Variance. The thresholds for these values are: CR > .70; AVE > .50 and CR > AVE; MSV < AVE and ASV < AVE (Hair et al., 2010). In bold are highlighted problematic values. Estimates were obtained through Stats Tool Package (Gaskin, 2011).

As shown in Table 4.20, some items, such as SN1 and SN3, presented relatively low standardised factor loadings (.39, and .23 respectively) and could have been considered the sources of low composite reliability for the subjective norm latent factor. Also PBC3 item was associated with a relatively low factor loading (.49) and this could have been translated into a lower AVE estimate. The other indicators presented moderate to strong standardized loadings, ranging from .66 (INT1) to .88 (SN2, INT2, INT3).

Table 4.20. Unstandardized and standardised parameter estimates, critical ratios, and item reliability for the hypothesised measurement model at baseline (n = 368)

Latent constructs	Items	Unstand. loading	Standardised loading	S.E.	CR	Item reliability	Residual variance
Attitude	ATT1	1.00	.69	.05	14.64	.47	.53
	ATT2	1.16	.82	.04	18.55	.67	.33
	ATT3	1.09	.75	.04	18.80	.57	.43
Subjective norm	SN1	1.00	.39	.07	5.45	.70	.30
	SN2	3.34	.88	.09	9.48	.55	.45
	SN3	.79	.23	.07	3.40	.24	.76
Perceived behavioural control	PBC1	1.00	.84	.04	23.89	.15	.85
	PBC2	.79	.74	.04	21.20	.78	.22
	PBC3	.55	.49	.06	8.22	.05	.95
Behavioural intention	INT1	1.00	.66	.05	14.13	.44	.56
	INT2	1.68	.88	.02	41.95	.78	.22
	INT3	1.63	.88	.03	33.88	.78	.22

Notes: CR is the critical ratio calculated by dividing the estimate by its standard error (S.E.). Values larger than 1.96 indicate $p < .05$; values larger than 2.58 indicate $p < .001$. All item loadings are significant at $p < .001$. Item reliability represents the squared multiple correlation (or R^2) for each item. Residual variance is the amount of variance unexplained by the indicator, which is associated with the error term.

Modification indices and standardised residual covariances were inspected in search for sources of ill fit. Modification indices generally suggest possible correlations between items or factors, which could improve the Chi-square test. In other terms, adding a correlation or a covariance between items or factors in the model would drop the value of the Chi-square by the value indicated by the modification index. Inspection of modification indices revealed many sources of ill fit, which were associated with values larger than 1. A large modification index (> 36) was found between the latent variable ATT and the error term associated with intention item INT1, which also loaded on the latent variable PBC. Another large modification index indicated a correlation between PBC2 and PBC3 items, and another one suggested the correlation between intention latent factor and ATT1 item. INT1, PBC3 and ATT1 items were also associated with standardised residual covariances larger than 2.0, which are additional indicators of ill fit.

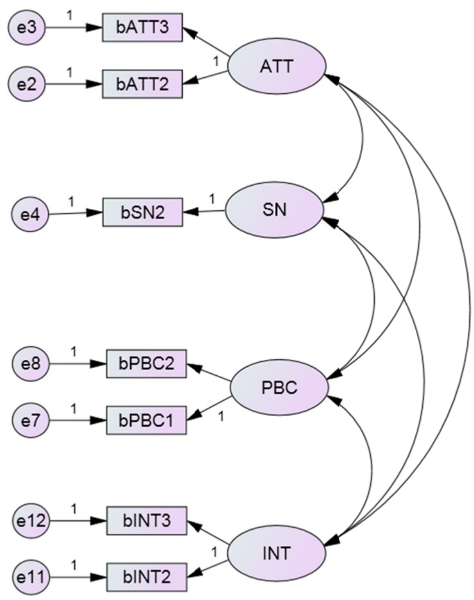

Figure 4.3. Adjusted CFA measurement model (with baseline indicators)

Since a conservative CFA approach was adopted, no cross-loadings between factors and no covariances between error terms were allowed. Therefore, all items with large modification indices suggesting potential correlations between items of different factors were dropped one at a time. The model was re-fitted to the data and global fit indices were inspected to see whether the model fit improved after the exclusion of one of the items. Only after having removed INT1, PBC3 and ATT1 items, the model started showing a moderate fit to the data (RMSEA = .047, 90% CI: .021 to .070, p close fit = .555; SRMR = .038, CFI = .986), except for the Chi-square test, which was still significant (χ^2 = 37.899, df = 21, p = .013). No modification indices larger than 10 were found, but some items still presented standardised residual covariaces larger than two. The items that did so were SN1 and SN3, which also had low factor loadings. Hence, it was decided to drop the problematic items and use SN2 as single indicator of the subjective norms latent factor.

After having excluded all problematic items, the final measurement model was re-fitted to the data. The adjusted model showed a good model fit (χ^2 = 13.737, df = 9, p = .132; SRMR = .016; RMSEA = .038, 90% CI: .00 to .076, PCLOSE = .654; CFI = .995). No validity or reliability concerns were raised by the data for behavioural intention (CR = .87, AVE = .77, MSV = .70, ASV = .38), attitude (CR = .80, AVE = .67, MSV = .21, ASV = .16), and perceived behavioural control (CR = .76, AVE = .62, MSV = .70, ASV = .36). Validity and reliability estimates for single indicators could not be computed, so subjective norm item SN2 had no validity and no reliability estimates. In order to keep the latent structure form, SN2 was included in the model as single indicator of the latent factor subjective norm. However, for the model to be identified, it was necessary to fix the factor loading to 1.0 and the error variance. In this case, the error variance was fixed to the 5% of the variance in that indicator[16] (see Jöreskog & Sörbom, 1989; Kline, 2005). In Table 4.21 are shown the estimates for the adjusted measurement model at baseline, which is represented in Figure 4.3. All items have standardised factor loadings larger than .70 and showed acceptable values for item reliability.

The estimated correlation between the latent factors representing TPB constructs were the following. The correlation between behavioural intention and attitudes was .58 (critical ratio = 4.15, p < .001, 95% CI: .45 to .71); with perceived behavioural control it was .82 (critical ratio = 8.68, p < .001, 95% CI: .74 to .89); with subjective norms it was .55 (critical ratio = 3.32, p = .001, 95% CI: .42 to .69). The estimated correlation between perceived behavioural control and attitudes was .52 (critical ratio = 4.75, p < .001, 95% CI: .38 to .65). The estimated correlation between subjective norms and attitudes was .33 (critical ratio = 2.54, p < .05, 95% CI: .18 to .48); with perceived

[16] The standard deviation of SN2 at baseline was 1.88, hence the variance (σ) was computed as SD squared = 3.53. The variance associated with the error term was fixed to the 5% (.18).

behavioural control the correlation was .43 (critical ratio = 3.58, $p < .001$, 95% CI: .30 to .57).

Table 4.21. Unstandardized and standardised parameter estimates, critical ratios, and item reliability for the adjusted measurement model at baseline (n = 368)

Latent constructs	Items	Unstand. loading	Standardised loading	S.E.	CR	Item reliability	Residual variance
Attitude	ATT2	1.00	.91	.06	14.91	.82	.18
	ATT3	.81	.72	.05	14.44	.52	.48
Perceived behavioural control	PBC1	1.00	.86	.04	23.99	.74	.26
	PBC2	.73	.71	.03	2.92	.50	.50
Subjective norm	SN2	1.00	.85	.01	96.24	.71	.29
Behavioural intention	INT2	1.00	.87	.03	3.63	.76	.25
	INT3	1.00	.89	.03	31.73	.79	.21

Notes: CR is the critical ratio calculated by dividing the estimate by its standard error (S.E.). Values larger than 1.96 indicate $p < .05$; values larger than 2.58 indicate $p < .001$. All item loadings are significant at $p < .001$. Item reliability represents the squared multiple correlation (or R^2) for each item. Residual variance is the amount of variance unexplained by the indicator, which is associated with the error term.

4.4.3.2 Measurement model at Time 1 and Time 2

Longitudinal measurement invariance tests brought some evidence that the structure of the latent factors (form) and the metric (factor loadings) of the items used to assess each TPB construct were invariant over time. To verify this assumption, the TPB measurement model tested at baseline was fitted to the data also at Time 1 and Time 2 follow-ups, following the procedure described above. As in baseline, the initial measurement model did not achieve a good fit with the data at both Time 1 (χ^2 = 166.039, df = 48, $p < .001$; RMSEA = .126, 90% CI: .11 to .15, PCLOSE < .001; SRMR = .085; CFI = .899) and Time 2 (χ^2 = 122.601, df = 48, $p < .001$; RMSEA = .107, 90% CI: .08 to .13, PCLOSE < .001; SRMR = .087; CFI = .919).

Similar issues of convergent and discriminant validity were found in Time 1 and Time 2 datasets. At Time 1, the following concerns were raised for subjective norms factor, and perceived behavioural control (see Table 4.22 below): the estimate of composite reliability (CR) for subjective norms factor was smaller than .70. For convergent validity, the average variance extracted (AVE) for perceived behavioural control was less than the average shared squared variance (ASV); the average variance extracted for subjective norm factor was less than .50 and smaller than the average shared squared variance. For discriminant validity, the square roots of the AVE for all factors (behavioural intention, attitudes, subjective norms, and perceived behavioural control) were smaller than 1.0 of the correlations with another factor, suggesting the presence of item cross-loadings.

Table 4.22. Composite reliability, convergent and discriminant validity estimates for the measurement model at Time 1 (n = 155)

Factors	CR	AVE	MSV	ASV	1	2	3	4
1. Behavioural intention	.911	.777	.828	.670	**.882**			
2. Attitude	.779	.543	.653	.529	.808	**.737**		
3. Perceived behavioural control	.785	**.563**	.828	.579	.910	.731	**.751**	
4. Subjective norm	**.562**	**.324**	.529	.435	.727	.633	.612	**.569**

Notes: CR is Composite Reliability; AVE is the Average Variance Extracted; MSV is Maximum Shared Squared Variance, and ASV is Average Shared Squared Variance. The thresholds for these values are: CR > .70; AVE > .50 and CR > AVE; MSV < AVE and ASV < AVE (Hair et al., 2010). In bold are highlighted the problematic issues. Estimates obtained through Stats Tool Package (Gaskin, 2011)

At Time 2, subjective norms presented some concerns with regards to composite reliability (CR = .55) and for convergent validity (AVE = .32; AVE < CR). Issues with regards to discriminant validity were found in perceived behavioural control and behavioural intention latent factors (see Table 4.23). The square roots of the AVE for behavioural intention, and perceived behavioural control were smaller than 1.0 of the correlations with another factor, suggesting the presence of item cross-loadings also in these factors.

Considering the results of the global fit indices and validity tests, modification indices and standardised indicators were inspected in search for sources of ill fit. Similar to baseline, modification indices suggested imposing cross-loadings between INT1 and the attitude latent factor, and between ATT1 and the behavioural intention latent factor.

Modification indices suggested imposing correlations between PBC2 and PBC3 items as well. As in baseline, cross-loading items were sequentially removed and global fit indices were checked after each modification, until an acceptable model fit was achieved and no modification indices larger than 10 were found.

Table 4.23. Composite reliability, convergent and discriminant validity estimates for the measurement model at Time 2 (n = 136)

Factors	CR	AVE	MSV	ASV	1	2	3	4
1. Behavioural intention	.893	.740	.834	.521	**.860**			
2. Attitude	.848	.651	.440	.305	.663	.807		
3. Perceived behavioural control	.761	.545	.834	.483	.913	.597	**.739**	
4. Subjective norm	**.547**	**.317**	.291	.222	.539	.344	.508	.563

Notes: CR is Composite Reliability; AVE is the Average Variance Extracted; MSV is Maximum Shared Squared Variance, and ASV is Average Shared Squared Variance. The thresholds for these values are: CR > .70; AVE > .50 and CR > AVE; MSV < AVE and ASV < AVE (Hair et al., 2010). In bold are highlighted the problematic issues. Estimates obtained through Stats Tool Package (Gaskin, 2011)

After removing ATT1, INT1 and PBC3 items from Time 1 model, the global fit indices showed an improved but yet not acceptable model fit (χ^2= 37.275, df = 21, p = .016; RMSEA = .057, 90% CI: .00 to .199, PCLOSE = .364; SRMR = .062; CFI = .981). At Time 2, after removing the same items, the model showed a moderate fit to the data: the Chi-square test was non-significant (χ^2 = 3.261, df = 21, p = .087); the RMSEA pointed towards a moderate fit (RMSEA = .057, 90% CI: .00 to .199) and the p value for close fit was significant (PCLOSE = .364); the SRMR was smaller than .05 (SRMR = .047) and the CFI was larger than .95 (CFI = .987). No modification indices larger than 10 were found, but inspecting the residual covariances matrix, some values larger than 2 were found in subjective norm items SN1 and SN3. These two items were also associated with low factor loadings at both time points (see Table 4.24).

After having removed the problematic items SN1 and SN3, the global fit indices pointed towards a good model fit for both Time 1 (χ^2 = 9.307, df = 9, p = .409; RMSEA =.015, 90% CI: .00 to .09; PCLOSE = .678; SRMR = .019; CFI = 1) and Time 2 (χ^2 = 12.073, df = 9, p = .209; RMSEA =.050, 90% CI: .00 to 116; PCLOSE = .439; SRMR =

.020; CFI = .995) follow-up data. At Time 1, the error variance of SN2 was fixed to (.15) and at Time 2 it was fixed to (.14).

Table 4.24. Unstandardized and standardised factor loading estimates and item reliability for the hypothesised measurement model at Time 1 and Time 2 follow-ups

		Time 1 (n = 155)				Time 2 (n = 136)			
Latent constructs	Items	Unstand. loading	Std. loading	Item reliability	Resid. Var.	Unstand. loading	Std. loading	Item reliability	Resid. Var.
Attitude	ATT1	1.00	.80	.64	.36	1.00	.72	.52	.48
	ATT2	.87	.75	.57	.43	1.24	.88	.77	.23
	ATT3	.72	.65	.42	.58	1.06	.81	.66	.34
Subjective norm	SN1	1.00	.52	.27	.73	1.00	.27	.07	.93
	SN2	1.96	.78	.60	.40	4.1	.78	.61	.39
	SN3	.78	.32	.10	.90	2.7	.52	.27	.73
Perceived behavioural control	PBC1	1.00	.92	.85	.15	1.00	.94	.88	.13
	PBC2	.74	.77	.60	.40	.76	.80	.64	.36
	PBC3	.49	.49	.24	.76	.36	.35	.12	.88
Behavioural intention	INT1	1.00	.70	.49	.52	1.00	.67	.45	.55
	INT2	1.71	.97	.94	.06	1.68	.96	.91	.09
	INT3	1.64	.95	.91	.09	1.64	.92	.85	.15

Notes: All factor loadings are significant at $p < .001$. All item loadings are significant at $p < .001$. Item reliability represents the squared multiple correlation (or R^2) for each item. Residual variance is the amount of variance unexplained by the indicator, which is associated with the error term.

In Table 4.25 are shown the estimates for the adjusted measurement models at Time 1 and Time 2. At Time 1, all items had standardised factor loadings above .70 (range .71 – .91). The estimated correlation between the behavioural intention latent factor and attitudes latent factor was .61 (critical ratio = 5.79, $p < .001$, 95% CI: .49 to .73); with perceived behavioural control it was .91 (critical ratio = 7.90, $p < .001$, 95% CI: .86 to .96); with subjective norms it was .72 (critical ratio = 6.13, $p = .001$, 95% CI: .59 to .84). The estimated correlation between perceived behavioural control latent factor and attitudes was .58 (critical ratio = 5.47, $p < .001$, 95% CI: .44 to .72). Lastly, the estimated correlation between subjective norms latent factor and attitudes was .36

(critical ratio = 3.12, p < .05, 95% CI: .17 to .55); with perceived behavioural control the correlation was .64 (critical ratio = 5.47, p < .001, 95% CI: 50 to .79).

At Time 2, the estimated factor loadings of TPB items included in the adjusted model had standardised factor loadings above .80 (range: .80 – .96). The estimated correlations between the latent factors representing TPB constructs were the following: between behavioural intention and attitudes the correlation was .59 (critical ratio = 5.03, p < .001, 95% CI: .46 to .72); with perceived behavioural control it was .92 (critical ratio = 7.41, p < .001, 95% CI: .88 to .97); with subjective norms it was .50 (critical ratio = 4.21, p = .001, 95% CI: .32 to .68). The estimated correlation between perceived behavioural control and attitudes was .55 (critical ratio = 4.81, p < .001, 95% CI: .41 to .70). The estimated correlation between subjective norms and attitudes was .28 (critical ratio = 2.31, p < .05, 95% CI: .06 to .49); with perceived behavioural control the correlation was .53 (critical ratio = 4.30, p < .001, 95% CI: .35 to .71).

Table 4.25. Unstandardized and standardised parameter estimates, critical ratios, and item reliability for the adjusted measurement models at Time 1 and Time 2

		Time 1 (n = 155)				Time 2 (n = 136)			
Latent constructs	Items	Factor loading	Std. loading	Item reliability	Resid. Var.	Factor loading	Std. loading	Item reliability	Resid. Var.
Attitude	ATT2	1.00	.91	.82	.18	1.00	.89	.98	.02
	ATT3	.81	.72	.52	.48	.86	.83	.69	.31
Perceived behavioural control	PBC1	1.00	.86	.74	.26	1.00	.93	.86	.14
	PBC2	.73	.71	.50	.50	.08	.80	.65	.35
Subjective norm	SN2	1.00	.85	.71	.29	1.00	.80	.63	.37
Behavioural intention	INT2	1.00	.87	.76	.25	1.00	.96	.92	.08
	INT3	.99	.89	.79	.21	.97	.92	.85	.16

Notes: All item loadings are significant at p < .001. Item reliability represents the squared multiple correlation (or R^2) for each item. Residual variance is the amount of variance unexplained by the indicator, which is associated with the error term.

Even though these measurement models were tested separately at baseline, Time 1 and Time 2, sample size was not a matter of concern for the estimated models, as indicated by the Critical N estimates output in AMOS. At baseline, the Critical N of the adjusted model was 454, at Time 1 it was 280 and Time 2 it was 190. These values were higher than the respective sample sizes (n = 368 for baseline, n = 155 for Time 1, and n = 136 for Time 2), suggesting that with a significance level of .05 the models were correct.

The results from the cross-sectional measurement model test, suggested that the TPB measurement model included overall acceptable and reliable measures of the hypothesised latent factors representing the constructs of the TPB. These findings confirmed the fact that the measurement structure and the metric were invariant over time, even when some items were dropped. Consequently, structural models building on the adjusted measurement models were not expected to achieve unacceptable fit with the data due to measurement issues.

4.4.4 Measurement invariance between intervention groups

Since one of the aims of this dissertation was to test the MoveM8 intervention effect on TPB variables and behaviour, a test for measurement invariance between intervention groups was conducted. This was done in order to determine the extent to which potential changes in individual's attitudes, subjective norms, perceived behavioural control, and behavioural intention were attributable to a variation in the measurement structure or to potential intervention effects. Measurement invariance between intervention groups (e-mail only vs. e-mail plus two SMS) was estimated using a traditional multiple-group measurement invariance approach, which is similar to the one described above for longitudinal measurement invariance (see, for example: Brown, 2006). This approach is commonly used to investigate differences in measurement structure and factors across different groups (i.e., gender, age groups, ethnicity, etc.) and it was used in the context of TPB (e.g., Nigg, Lippke, & Maddock, 2009) and in the application and development of a measurement instrument in the domain of physical activity (e.g., Pickering & Plotnikoff, 2009). In multi-group measurement invariance the initial model (equal form) with no constraints is first fit in separately in each group (single-group solution).

The tested baseline CFA model is the one presented in the previous paragraph and depicted in Figure 4.3. If the model achieved good fit in each group, then the next step (test for equal form) could be undertaken in a multiple-group solution. If equal form model achieved a good fit, then the whole measurement structure could be said invariant between groups. As in longitudinal measurement invariance, equal factor loadings (metric invariance), equal intercepts (scalar invariance) and equal residual variances (strong factorial invariance) were tested by comparing nested models building upon each other with additional, more stringent constraints. In group measurement invariance, the equality constraints are imposed between groups on like items. For example, a test for metric invariance (equal factor loadings) sets the factor loadings of one item to be equal in group one and in group two, and so on.

As in longitudinal measurement invariance, to establish if a level of invariance was achieved, the Chi-square difference, in combination with minimal change in the comparative fit index (CFI), between the unconstrained model and the more stringent nested model were utilised. If the Chi-square difference between the two models was non-significant and if the ΔCFI was below -.01 (Cheung & Rensvold, 2002; Vandenberg & Lance, 2000), the nested model did not significantly differ from the less constrained one, hence providing evidence for metric, scalar or strict factorial invariance. Tests were conducted in Mplus using the previously mentioned Satorra-Bentler (2001) scaled Chi-square tests with estimates obtained with the MLR robust estimator, used to correct for non-normality.

The factor loading of the first item in each latent factor (attitudes, subjective norms, perceived behavioural control, and behavioural intention) was fixed to 1.0 to set its scale, and the mean of the latent factor was fixed to zero for the purpose of model identification. The other factor loadings, intercepts, residual variances and factor variances and covariances were unconstrained. Since for subjective norms latent factor, a single indicator was used, the residual variance of the SN2 indicator had to be fixed, for the purpose of model identification. For example, at baseline, SN2 error variance was fixed to .18 for the overall equal form model (5% of the variance in that indicator), and in each group the error variance was fixed according to the group-specific variance (e.g., for intervention group 1 it was .19 and for group 2 it was .16), based on the standard deviation of the item in the two groups. The estimates changed in Time 1 and Time 2 according to the standard deviation of the subsamples achieved in each time point. Results of the Chi-square difference tests as well as global model fit indices of the tested models for both time points are presented in Table 4.26.

Baseline comparisons

The hypothesised measurement model achieved a good fit in both groups as testified by the global fit-indices and by the absence of modification indices. Therefore, a test for measurement invariance could be undertaken. The first model (equal form) achieved a good fit with the data (χ^2 = 23.137, df = 18, p = .185; RMSEA = .039, 90% CI: .000 to .081; PCLOSE = .615; SRMR = .021; CFI = .994), suggesting that the measurement structure generalised between groups. Data provided evidence also for metric and scalar invariance for the TPB measurement model at baseline in both intervention groups. The scaled Chi-square difference tests between equal factor loadings and equal form models and between equal factor loadings and equal item intercepts models were all non-significant, indicating that factor loadings measuring the same latent factors and their means were invariant between groups.

A significant scaled Chi-square difference tests between equal item intercepts and equal error variances models indicated that strong factorial invariance between groups was not achieved at baseline (i.e., error variances were not invariant between groups). Nevertheless, this was not considered a major problem, as the scope of this test was to determine whether the measurement structure, the item factor loadings and item intercepts were equivalent in both groups (Brown, 2006). Since participants were randomly assigned to one of the two experimental conditions, differences in residual variances could be attributable to chance or to many other reasons independent from the measurement structure. In fact, the results obtained with follow-up data support this interpretation.

Time 1 and Time 2 follow-ups

Consistent with the findings obtained with baseline data, the hypothesised measurement models achieved a good fit with the data in both groups separately at each time point. Data supported the evidence for configural invariance between intervention groups at Time 1 (χ^2 = 14.203, df = 18, p = .72; RMSEA = .000, 90% CI: .000 to .077; PCLOSE = .856; SRMR = .021; CFI = 1.000) and Time 2 (χ^2 = 2.925, df = 18, p = .28; RMSEA = .049, 90% CI: .000 to .123; PCLOSE = .464; SRMR = .026; CFI = .994). The measurement structure remained significantly invariant between groups in each time point, supporting, *de facto*, the evidence for equal form measurement invariance over time also in both groups.

Data also supported the evidence for metric, scalar and strong factorial measurement invariance for both intervention and control groups at both time points, as testified by non-significant scaled Chi-square difference tests between the models and minimal changes in CFI. These results indicated that the factor structure and the items were not invariant, and thus comparisons between groups could be made also without taking into account the measurement structure (e.g., by using composite scores). These findings supported the assumption that the variation in item error variances at baseline could be attributable to chance, as data provided evidence for strong factorial invariance at both Time 1 and Time 2. Moreover, the factor structure as well as the meaning associated with items and latent constructs remained invariant between intervention groups post-baseline. In conclusion, the measurement model did not significantly vary across intervention groups and if a change occurred over time it was independent from the measurement structure and from the items used.

Table 4.26. Chi-square difference tests and fit indices for measurement invariance models between intervention groups at three time points

Model	χ^2	df	CFI	$\Delta\chi^2$	Δdf	ΔCFI	RMSEA (90% CI)	CFit	SRMR
Baseline (N = 368)									
Single group solutions									
E-mail only (n = 185)	9.42	9	1.00	-	-	-	.016 (.000 - .085)	.711	.018
E-mail plus SMS (n = 183)	14.06	9	.99	-	-	-	.055 (.000 - .108)	.383	.024
Measurement invariance									
Equal form	23.14	18	.99	-	-	-	.039 (.000 - .081)	.615	.021
Equal factor loadings	25.30	21	1.00	1.98	3	.00	.033 (.000 - .074)	.705	.028
Equal item intercepts	29.96	28	1.00	4.33	7	.00	.019 (.000 - .061)	.859	.030
Equal item error variances	48.86	34	.98	15.63*	6	-.02	.049 (.000 - .077)	.498	.035
Time 1 (n = 155)									
Single group solutions									
E-mail only (n = 83)	4.41	9	1.00	-	-	-	.000 (.000 - .064)	.930	.019
E-mail plus SMS (n = 72)	9.41	9	1.00	-	-	-	.024 (.000 - .127)	.558	.022
Measurement invariance									
Equal form	14.20	18	1.00	-	-	-	.000 (.000 - .077)	.856	.021
Equal factor loadings	15.20	21	1.00	1.03	3	.00	.000 (.000 - .061)	.920	.029
Equal item intercepts	23.06	28	1.00	7.90	7	.00	.000 (.000 - .066)	.891	.086
Equal item error variances	3.65	34	1.00	6.64	6	.00	.000 (.000 - .071)	.851	.103
Time 2 (n = 136)									
Single group solutions									
E-mail only (n = 68)	14.98	9	.97	-	-	-	.099 (.000 - .184)	.170	.029
E-mail plus SMS (n = 68)	6.31	9	1.00	-	-	-	.000 (.000 - .104)	.558	.023
Measurement invariance									
Equal form	2.93	18	.99	-	-	-	.049 (.000 - .123)	.464	.026
Equal factor loadings	23.47	21	1.00	2.62	3	.00	.042 (.000 - .114)	.519	.041
Equal item intercepts	33.74	28	.99	1.28	7	-.01	.055 (.000 - .114)	.421	.086
Equal item error variances	4.57	34	.99	6.96	6	.00	.053 (.000 - .108)	.436	.100

Notes: $\Delta\chi 2$ = nested Chi-square difference between models; Δdf = difference in degrees of freedom between nested models; ΔCFI = difference in CFI between nested models. RMSEA = square error for approximation; 90% CI = confidence interval for the RMSEA; CFit = test for close fit (PCLOSE), i.e., the probability for the RMSEA to be $\leq .05$; SRMR = standardised root mean square residual. Estimates were calculated using the robust maximum likelihood estimator (MLR) as implemented in Mplus (Muthén & Muthén, 2011). The chi-square difference test is scaled based on the formula initially provided by Satorra (2000).

4.5 Analysis of the structural models

The final step of the analysis involved a series of structural equation models, where causal paths were added between the TPB latent factors and behaviour, according to the original Theory of Planned Behaviour model as presented in Chapter Two and following the analysis strategy described in Chapter Three. Analyses of in this part focused on the evaluation of paths (regression coefficients) between variables, having already verified that the measurement part of the model was fitting well with the data and that it was stable over time.

The analysis of structural models was used in line with the two objectives and research questions presented in this dissertation. The first objective was to test whether the TPB model was a good predictor of the behaviours under scrutiny (workplace physical activity, leisure-time physical activity and total physical activity); the second was to test whether the intervention had effects on TPB items and physical activity behaviour in a sample of employees participating in the MoveM8 programme.

Objective one

For the first objective, two models were tested. One tested the impact of the TPB model at baseline predicting behaviour at Time 1, and the other tested the impact of the TPB model predicting behaviour at Time 2. An example of the first model is depicted in Figure 4.5, which does not include item indicators measuring latent factors for a matter of simplicity. On the left hand side of the figure are the latent factors postulated by the TPB model (Ajzen, 1985; Ajzen & Fishbein, 2010). The items used to assess each latent construct were identified through the confirmatory factor analytic approach described in the previous paragraphs. Attitude, perceived behavioural control and behavioural intention latent factors were measured using two indicators each, whereas subjective norm factor was assessed only through SN2 item. For the purpose of model identification, the residual of the item representing the subjective norms latent factor was fixed to the 5% of its variance at each time point, as previously described and suggested by SEM literature (e.g., Jaccard & Wan, 1995; Jöreskog & Sörbom, 1989).

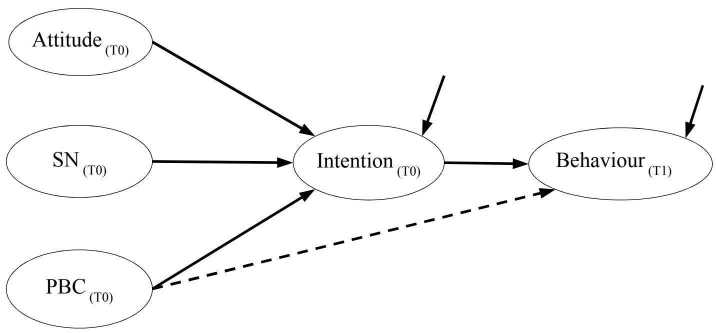

Figure 4.4. The TPB structural model predicting behaviour at Time 1

On the right side of the model is included the latent factor representing prospective behaviour (in the illustration, leisure-time physical activity at Time 1), measured through the IPAQ summary variables for each physical activity domain (i.e., work, leisure-time and total physical activity). Also the latent factor representing behaviour had a fixed residual variance for model identification purposes. This representation of latent factors through single indicators allowed accounting for measurement error. An alternative representation of the TPB model with a direct path between PBC and behaviour was also tested and data showed that the path was non-significant, corroborating the theoretical assumption that behavioural intention fully mediates the influence of perceived behavioural control on behaviour (e.g., Ajzen, 1985; Hagger, Chatzisarantis, Biddle, et al., 2001). All following results did not include the path between PBC and behaviour.

An alternative extension of this model included also past behaviour as predictor of attitudes, subjective norms, perceived behavioural control at baseline, and behaviour at Time 1. Likewise, an alternative version of the second model, included past behaviour, collected at Time 1 as predictor of TPB latent constructs and behaviour at Time 2. Past behaviour was added to the model because past behaviour (baseline physical activity) was strongly associated with prospective behaviour measured at Time 1 and Time 2 and with most of the TPB items measured at all three time points.

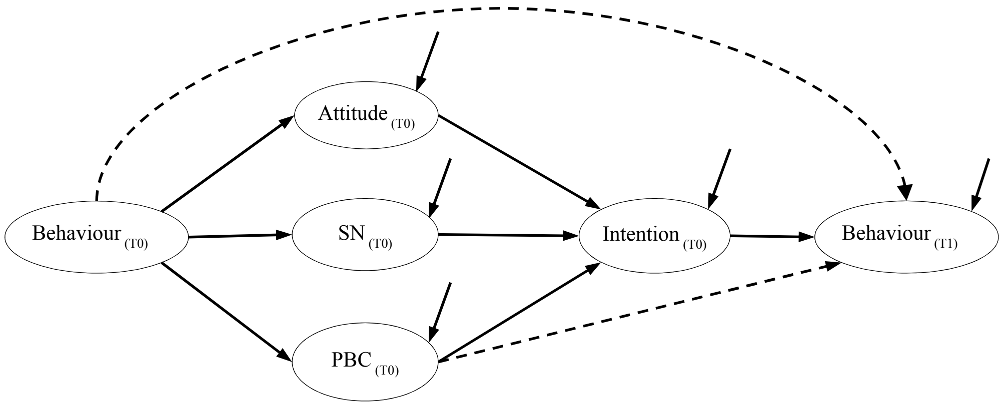

Figure 4.5. Graphical representation of the TPB structural model predicting behaviour at Time 1 and including past behaviour

Objective two

For the second objective of this dissertation, the effect of the intervention on the TPB model and on physical activity outcome variables was tested using an auto-regressive longitudinal MIMIC[17] model. With this approach, the intervention group was included as a predictor of TPB latent factors and post-test physical activity behaviour. The longitudinal model built upon the previous two cross-sectional models and constituted also a test for auto-regressive effects on TPB latent factors over two time points. The test of this model was based on an example provided by Hagger et al. (2001).

A graphical representation of the model is shown in Figure 4.6. In this illustration the relations between variables of the TPB model are presented. The dashed lines represent auto-regressive effects (i.e., a latent factor at baseline predicted itself at Time 1). The item indicators of each latent factor (the ellipses) are not included for clarity.

[17] In SEM context, MIMIC stands for "Multiple Indicators Multiple Causes" models. These models include the potential moderator or grouping variable as covariate or as predictor of the other variables present in the model instead of using a multiple-group approach. A MIMIC model can be used instead of a multiple-group approach in case of small samples and complex moderation relationships in complex models (Kline, 2005).

Arrows pointing towards the latent factor without any text on them indicate disturbance terms, which reflect the proportion of unexplained variance in the endogenous variables. The intervention effect is conceived as direct path from the intervention group variable (dichotomous: e-mail only = 0, e-mail plus SMS = 1) to the outcome variables.

The longitudinal model did not include TPB variables at Time 2 for the following reasons. First, because the intervention happened between baseline and Time 1. It was hypothesised that if any changes had occurred, these would have happened at immediate post-test, according to the literature about web-based intervention effects (e.g., Vandelanotte et al., 2007). Second, because independent-sample t-tests revealed that the intervention had significant but small effects (eta squared around .02) on some TPB items only at Time 1 (i.e., ATT2, PBC1 and INT3) and no effect on physical activity behaviours at Time 1 and Time 2. Third, because longitudinal measurement invariance provided evidence for temporal stability of the latent factors, hence including a further causal relationship with prospective measures would be redundant; fourth, but not less important, because the higher the complexity of the model, the more likely misspecification can occur (i.e., too many parameters to be estimated and limited number of cases).

Cross-sectional and longitudinal models evaluated the impact of TPB model on each behavioural outcome (i.e., LTPA, WPA, and TOTPA) separately, using a limited information approach. This was done to test whether the intervention had effects on the specific behaviours it addressed. Results are presented accordingly. Similar to the other CFA models presented in the previous paragraphs, the model fit was evaluated using the model fit criteria outlined in Chapter Three. Estimates were computed using Mplus v6.12 with a robust maximum likelihood algorithm, which corrected for the non-normality of the observed measures. The analyses presented in the following paragraphs focus on the evaluation of paths (regression coefficients) between variables, as the measurement step was thoroughly covered in paragraph 4.4. The following description of the results is organised by research objectives.

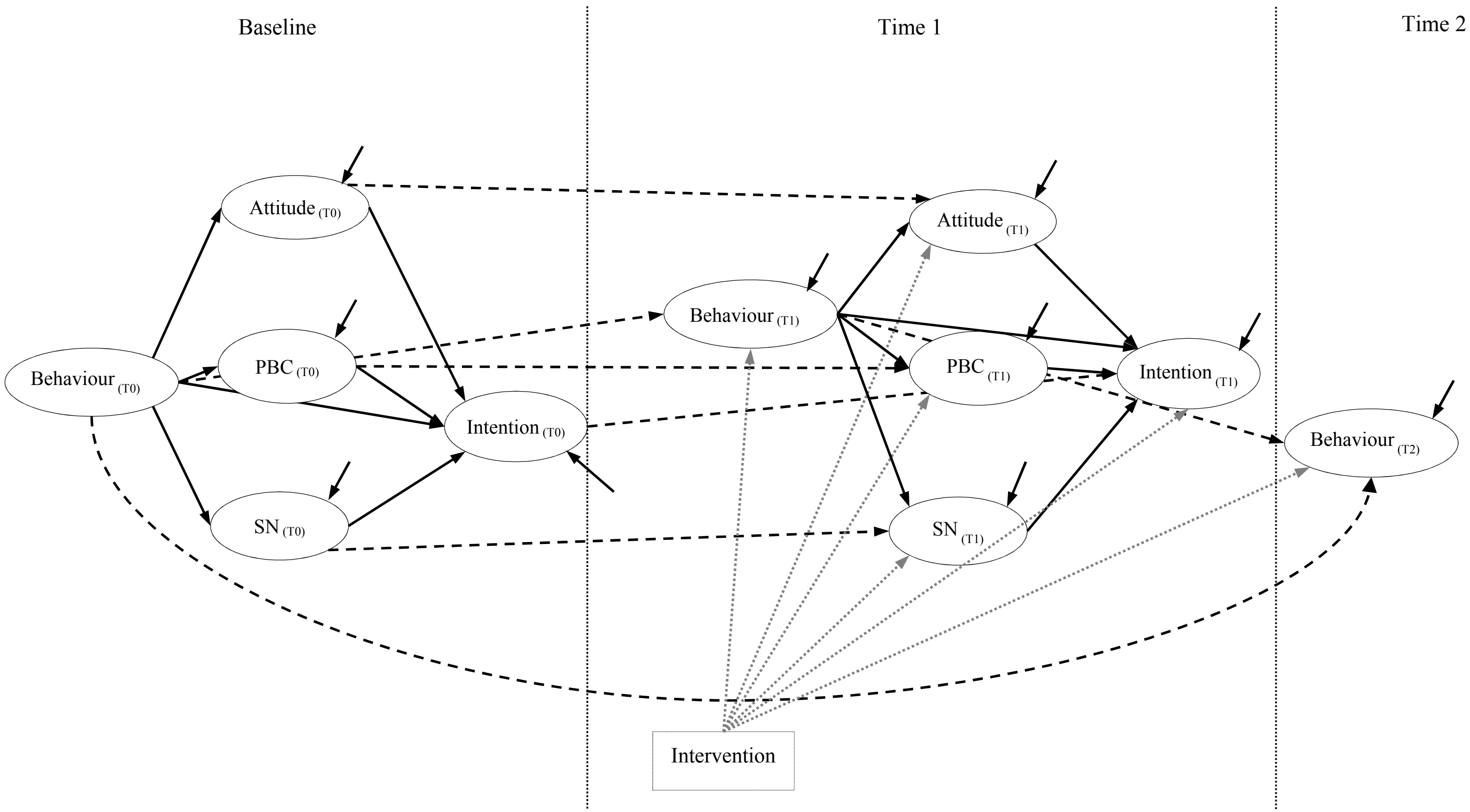

Figure 4.6. Longitudinal MIMIC model with intervention predicting Time 1 TPB latent factors, and prospective behaviour

4.5.1 Predictive utility of the TPB model on behaviour at Time 1

Leisure time physical activity

The model presented in Figure 4.5 was first tested only with leisure-time physical activity as outcome variable. The overall Chi-square test of model fit was statistically non-significant (χ^2 = 21.703, df = 15, p = .116), the root mean square error of approximation was below .001 (RMSEA = .000, 90% CI: .000 – .077). The p value for the test of close fit was also significant (PCLOSE = .856), the standardised root mean square residual was = .021 and the CFI was 1.000. All the indices uniformly suggested good model fit. Inspection of residuals and of modification indices revealed no theoretically meaningful sources of ill fit.

In Table 4.27 are presented the parameter estimates for the structural coefficients and the coefficients for the total effects of the variables implied by the TPB model predicting behaviour at Time 1, including all relevant mediational chains. Perceived behavioural control accounted for 73% and subjective norms for 17% of the variance in behavioural intention. Only the path from attitudes to intention was non-significant. Standardised disturbance terms are shown in Table 4.30 at the end of the paragraph. Standardised disturbance represent the proportion of unexplained variance in the endogenous variables (i.e., behavioural intention and physical activity behaviour at Time 1). The standardised disturbance on behavioural intention was .26, indicating that overall the TPB model accounted for the 70% of the variance in intention, as indicated by the standardised disturbance on the variable.

The model predicted that for every one unit increase in PBC, behavioural intention was predicted to increase, on average, of .63 scale units; for every unit increase in subjective norms scale, intention was predicted to increase of .13 scale units.

Even though the literature supports the role of PBC in predicting behavioural intention, the non-significant contribution of attitudes in the TPB is unusual. To check whether this was mainly due to the presence of PBC in the model, a test was done by fixing PBC-intention paths coefficients to zero, as also Hagger and colleagues did in their study (Hagger, Chatzisarantis, Biddle, et al., 2001). This restored the significance to the path coefficients between attitudes and intention (β = .44, p < .001) at both baseline and at Time 1 across all models tested. This suggested that PBC alone truly accounted for the majority of the variance in behavioural intention in all models.

Table 4.27. Path coefficients for the TPB model predicting LTPA at Time 1 (n = 361)

Path	B	B 95% CI		β
Original TPB model				
Attitude to Intention	.08	-.04	.20	.08
Perceived behavioural control to Intention	.63**	.47	.79	.73
Subjective norm to Intention	.13**	.05	.21	.17
Intention to LTPA(T1)	5.31**	2.75	7.87	.37
Total effects on behaviour				
Attitude(T0) on LTPA(T1)	.43	-.28	1.13	.03
PBC(T0) on LTPA(T1)	3.34**	1.64	5.05	.27
SN(T0) on LTPA(T1)	.69*	.14	1.24	.06
Alternative model including past behaviour				
Attitude to Intention	.07	-.06	.20	.07
Perceived behavioural control to Intention	.63**	.47	.79	.73
Subjective norm to Intention	.13**	.05	.21	.17
Intention to LTPA(T1)	2.24	-.18	4.65	.16
Past behaviour to TPB(T0)				
LTPA(T0) to Attitude(T0)	.03**	.02	.03	.37
LTPA(T0) to PBC(T0)	.03**	.01	.03	.36
LTPA(T0) to Subjective norm (T0)	.02**	.02	.04	.19
LTPA(T0) to Intention(T0)	.00	.00	.01	.02
LTPA(T0) to LTPA(T1)	.56**	.34	.77	.51
Total effects on behaviour at Time 1				
Attitude(T0) on LTPA(T1)	.16	-.19	.51	.01
PBC(T0) on LTPA(T1)	1.41	.13	2.93	.13
SN(T0) on LTPA(T1)	.29	-.081	.66	.03
LTPA(T0) on LTPA(T1)	.61**	.41	.82	.57

Notes: B = unstandardized coefficient, β = standardised coefficient; 95% CI is the 95% confidence interval for the unstandardized coefficient; LTPA stands for leisure-time physical activity; T0 and T1 indicate the time of measurement: T0 = baseline, T1 = Time 1 (12 weeks after baseline). * p < .05, ** p < .001.

Behavioural intention was a significant preditor of behaviour at Time 1 (β =.37, $p < .001$), indicating that for evey unit increase on the behavioural item scale, leisure-time physical activity variable was predcited to increase by 5.31 MET-hours/week. The coefficients for the total effects of PBC and subjective norms on behaviour indicated that these two latent factors had a significant indirect effect on behaviour at Time 1 (β_{PBC} =.27, $p < .001$; β_{SN} =.06, $p < .05$): for every unit increase on PBC scale, there was an increase of 3.34 MET-hours/week in leisure-time physical activity at Time 1; for every unit increase in subjective norms LTPA at Time 1 was predicted to increase by .69 MET-hours/week. The indirect effect of attitudes on behaviour was non-significant, corroborating the fact that attitudes did not significantly predict behavioural intention.

The alternative model with baseline TPB predicting Time 1 behaviour including past behaviour was also tested. The model achieved a good fit with the data (χ^2 = 19.483, df = 18, p = .363; RMSEA = .015, 90% CI: .000 – .050; PCLOSE = .948; SRMR = .022; CFI = .998). Past behaviour was a significant and strong predictor of attitudes, subjective norms and perceived behavioural control latent factors at baseline, indicating that every MET-hour/week increase in leisure-time physical activity, attitudes, subjective norms and perceived behavioural contol were predicted to increase of about .03 units on their respective scales.

The path from past behaviour to behavioural intention at baseline was non-significant and the effects were close to zero, indicating that the relationship was fully mediated by the determinants of intention as prescribed by the TPB model. Additionally, while the effect of PBC and subjective norms on behavioural intention was unchanged, the addition of past behaviour to the model reduced the impact of behavioural intention on behaviour, as testified by the non-significant path coefficient between the two latent factors. Also the indirect effects of PBC and subjective norms became non-significant compared to past behaviour. In fact, past behaviour was a significant predictor of prospective behaviour, accounting for 51% of the variance (β = .51, $p < .001$). The total effect of past behaviour on prospective behaviour was also significant (β = .57, $p < .001$), indicating that for every one MET-hour/week increase in past behaviour, prospective behaviour was predicted to increase of .61 MET-hours/week. Since the impact of behavioural intention was weak, and considering the high impact of PBC, an interaction effect between intention and PBC could be hypothesised, because higher levels of PBC were associated with stronger intention-behaviour relationships (Armitage & Conner, 2001). Interaction effects between PBC and intention were inspected and a significant interaction effect was found on leisure-time physical activity at Time 1 ($\beta_{PBCxINT} = 1.11$, $p = .001$).

Workplace physical activity

The model with workplace physical activity variable reached a moderate fit with the data, as indicated by the significant Chi-square test and by borderline values of RMSEA and CFI ($\chi^2 = 28.276$, df = 15, $p = .020$; RMSEA = .050, 90% CI: .019 – .077; PCLOSE = .473; SRMR = .035; CFI = .983). No modification indices larger than 10 and no standardised residuals larger than 2.0 were found; the model was considered valid, as it showed a moderate but acceptable fit. The parameter estimates for the structural coefficients are presented in Table 4.28, whereas the standardised disturbance terms are shown in Table 4.30.

Similar to the model with leisure-time physical activity, PBC was the strongest significant predictor of intention ($\beta = .74$, $p < .001$), subjective norms was the second strongest predictor ($\beta = .17$, $p < .001$), and attitudes was not a significant predictor of behavioural intention ($\beta = .07$, $p > .05$). Overall, the TPB model accounted for the 74% of the variance in behavioural intention. However, the path between behavioural intention and workplace physical activity behaviour was non-significant, indicating that the TPB model did not predict prospective behaviour in the work domain. This was also confirmed by the non-significant total effects of the TPB components on behaviour.

The model including past behaviour as predictor of TPB constructs exhibited satisfactory goodness-of-fit statistics ($\chi^2 = 26.949$, df = 18, $p = .080$; RMSEA = .037, 90% CI: .000 – .064; PCLOSE = .754; SRMR = .027; CFI = .989). The alternative model achieved a better fit with the data than the previous model, but past behaviour was not a significant predictor of any of the TPB items (all paths were non-significant). All paths from attitudes, subjective norms and PBC to intention remained unchanged, so these constructs accounted for about 74% of the variance in behavioural intention. The addition of past behaviour increased the value of the path from intention to behaviour, but it was still non-significant ($\beta = .03$, $p > .05$).

Table 4.28. Path coefficients for the TPB model predicting WPA at Time 1 (n = 361)

Path	B	B 95% CI		β
Original TPB model				
Attitude to Intention	.08	-.05	.20	.07
Perceived behavioural control to Intention	.64**	.48	.79	.74
Subjective norm to Intention	.13**	.05	.21	.17
Intention to WPA(T1)	.08	-1.17	1.33	.01
Total effects on behaviour				
Attitude(T0) on WPA(T1)	.01	-.09	.10	.00
PBC(T0) on WPA(T1)	.05	-.75	.85	.01
SN(T0) on WPA(T1)	.01	-.15	.17	.00
Alternative model including past behaviour				
Attitude to Intention	.07	-.05	.20	.07
Perceived behavioural control to Intention	.63**	.47	.79	.74
Subjective norm to Intention	.13**	.05	.21	.18
Intention to WPA(T1)	.24	-.76	1.24	.03
Past behaviour to TPB(T0)				
WPA(T0) to Attitude(T0)	.00	-.01	.02	.01
WPA(T0) to PBC(T0)	.01	-.01	.03	.08
WPA(T0) to Subjective norm(T0)	.01	-.01	.03	.08
WPA(T0) to Intention(T0)	-.01	-.02	.00	-.05
WPA(T0) to WPA(T1)	.46**	-.01	.03	.50
Total effects on behaviour at Time 1				
Attitude(T0) on WPA(T1)	.02	-.06	.10	.00
PBC(T0) on WPA(T1)	.15	.48	.79	.03
SN(T0) on WPA(T1)	.03	-.10	.17	.01
WPA(T0) on WPA(T1)	.46**	.29	.64	.5

Notes: B = unstandardized coefficient, β = standardised coefficient; 95% CI is the 95% confidence interval for the unstandardized coefficient; WPA stands for workplace physical activity; T0 and T1 indicate the time of measurement: T0 = baseline, T1 = Time 1 (12 weeks after baseline). * p < .05, ** p < .001.

The only significant predictor of prospective behaviour was physical activity at baseline ($\beta = .50$, $p < .001$), which accounted for about 50% of the variance of WPA at Time 1, with a total effect on prospective behaviour of .50. For every unit increase in WPA at baseline, WPA at Time 1 was predicted to increase, on average, by .46 MET-hours/week. A test for interaction effects between PBC and intention revealed no significant interaction ($\beta_{PBCxINT} = .01$, $p > .05$).

Total physical activity

The models with total physical activity outcome variable showed results comparable with those obtained with leisure-time physical activity. The first model (Figure 4.5) exhibited a good fit with the data ($\chi^2 = 20.583$, df = 15, $p = .151$; RMSEA = .032, 90% CI: .000 to .063; SRMR = .034; CFI = .993). The parameter estimates for the structural coefficients and the standardised disturbance terms are presented in Table 4.28 and Table 4.30 respectively. Consistent with the results found in the models with the other behavioural outcomes, attitudes was not a significant predictor of behavioural intention whereas PBC was the strongest significant predictor of intention ($\beta = .73$, $p < .001$), followed by subjective norms ($\beta = .17$, $p < .001$). Again, the TPB model (including subjective norms, perceived behavioural control and attitudes) accounted for the 74% of the variance in behavioural intention, as indicated by the standardised disturbance on the variable. Behavioural intention was a significant predictor of behaviour at Time 1 as indicated by the significant path from these two variables ($\beta = .35$, $p < .001$). For every unit increase on the behavioural intention scale, total physical activity at Time 1 was predicted to increase by 9.78 MET-hours/week. Perceived behavioural control and subjective norms had also significant indirect effects on behaviour at Time 1 ($\beta_{PBC} = .25$, and $p < .001$; $\beta_{SN} = .06$, $p < .05$): holding constant the other variables in the model, one unit increase in PBC and subjective norms corresponded to an increase of 6.18 MET-hours/week and 1.29 MET-hours/week in the total physical activity score at Time 1 respectively.

The inclusion of past behaviour in the model showed satisfactory and positive goodness-of-fit statistics: $\chi^2 = 26.336$, df = 18, p = .092; RMSEA = .036, 90% CI: .000 – .063; SRMR = .028; CFI = .991. Past behaviour was a significant predictor of attitudes, subjective norms and perceived behavioural control at baseline, suggesting that highly active people tended to score higher on these items.

Table 4.29. Path coefficients for the TPB model predicting TOTPA at Time 1 (n = 361)

Path	B	B 95% CI		β
Original TPB model				
Attitude to Intention	.08	-.05	.20	.08
Perceived behavioural control to Intention	.63**	.05	.79	.73
Subjective norm to Intention	.13**	.05	.21	.17
Intention to TOTPA(T1)	9.78**	.50	14.53	.35
Total effects on behaviour				
Attitude(T0) on TOTPA(T1)	.78	-.54	2.09	.03
PBC(T0) on TOTPA(T1)	6.18**	3.00	.9.36	.25
SN(T0) on TOTPA(T1)	1.29*	.25	2.33	.06
Alternative model including past behaviour				
Attitude to Intention	.08	-.05	.20	.07
Perceived behavioural control to Intention	.62**	.47	.78	.73
Subjective norm to Intention	.13*	.05	.21	.17
Intention to TOTPA(T1)	6.02*	1.34	1.69	.21
Past behaviour to TPB(T0)				
TOTPA(T0) to Attitude(T0)	.01*	.00	.01	.21
TOTPA(T0) to PBC(T0)	.01**	.01	.02	.15
TOTPA(T0) to Subjective norm(T0)	.01*	.00	.01	.26
TOTPA(T0) to Intention(T0)	.00	.00	.00	.03
TOTPA(T0) to TOTPA(T1)	.53**	.36	.69	.49
Total effects on behaviour at Time 1				
Attitude(T0) on TOTPA(T1)	.46	-.40	1.31	.02
PBC(T0) on TOTPA(T1)	3.74*	.81	6.68	.15
SN(T0) on TOTPA(T1)	.79	-.03	1.61	.04
TOTPA(T0) on TOTPA(T1)	.58**	.44	.73	.55

Notes: B = unstandardized coefficient, β = standardised coefficient; 95% CI is the 95% confidence interval for the unstandardized coefficient; TOTPA stands for total physical activity; T0 and T1 indicate the time of measurement: T0 = baseline, T1 = Time 1 (12 weeks after baseline). * p < .05, ** p < .001.

Past behaviour attenuated the effect of behavioural intention on prospective behaviour ($\beta = .21$, $p < .05$), and of PBC on intention ($\beta = .73$, $p < .001$). Past behaviour had a significant total effect on TOTPA at Time 1 ($\beta = .55$, $p < .001$), and only PBC had a significant indirect effect on prospective behaviour ($\beta = .15$ $p < .05$), but this effect was attenuated in comparison with the previous model. Likewise, past behaviour reduced also the indirect effect of subjective norms on prospective behaviour, which became non-significant ($\beta = .04$, $p > .05$). Testing for interaction effects between PBC and intention showed no significant effect on prospective behaviour due to the PBCxIntention interaction ($\beta_{PBCxINT} = .04$, $p = .98$).

Table 4.30. Standardised disturbance terms for all TPB models predicting behaviour at Time 1

Endogenous variable	LTPA	WPA	TOTPA
Original TPB model			
Intention(T0)	.26	.26	.26
Behaviour(T1)	.86	1.00	.88
Alternative model including past behaviour			
Attitude(T0)	.87	1.00	.96
PBC(T0)	.87	.99	.93
Subjective norm(T0)	.97	.99	.98
Intention(T0)	.26	.26	.26
Behaviour (T1)	.66	.75	.66

Notes: LTPA = leisure-time physical activity; WPA = workplace physical activity, TOTPA = total physical activity; T0 and T1 indicate the time of measurement: T0 = baseline, T1 = Time 1 (12 weeks after baseline). * p < .05, ** p < .001.

4.5.2 Predictive utility of the TPB model on behaviour at Time 2

Similar results were found in models testing the TPB at Time 1 and predicting behaviour at Time 2, therefore results are briefly summarised below. Analyses were conducted using a smaller sample ($n = 185$), which excluded cases with missing values on all Time 1 and Time 2 variables. These models were corrected for clustering effects as implemented in Mplus. Tables with the unstandardized and standardised regression estimates are provided in Annex A (Tables 7.10-7.12). The model presented in Figure

4.5 achieved a good model fit across all behaviours at Time 2: leisure-time physical activity (χ^2 = 12.626, df = 15, p = .631; RMSEA = .000, 90% CI: .000 to .059; PCLOSE = .906; SRMR = .025; CFI = 1.000); workplace physical activity (χ^2 = 14.077, df = 15, p = .520; RMSEA = .000, 90% CI: .000 to .066; PCLOSE = .854; SRMR = .023; CFI = 1.000); and total physical activity (χ^2 = 15.219, df = 15, p = .436; RMSEA = .000, 90% CI: .000 to .071; PCLOSE = .805; SRMR = .027; CFI = 1.000). The path from attitudes to intention was not statistically significant in all models; PBC and subjective norms were significant predictors of behavioural intention also at Time 2, predicting about the 75% of the variance in behavioural intention across the three behaviours. The effects of both PBC and subjective norms on behavioural intention at Time 1 were slighlty stronger than baseline: for leisure-time and workplace physical activity (β_{PBC} = .75, $p < .001$; β_{SN} = .15, $p < .001$); for total physical activity (β_{PBC} = .76, $p < .05$; β_{SN} = .15, $p < .001$). The overall TPB model accounted for 85% of the variance in behavioural intention across all behaviours, and the 11% of the variance in behaviour. Perceived behavioural control and subjective norms showed significant indirect effects on behaviour at Time 2 in the models with leisure-time (β_{PBC} = .20, $p < .05$; β_{SN} = .04, $p < .05$) and total physical activity (β_{PBC} = .25, $p < .05$; β_{SN} = .05, $p < .05$). No significant indirect or direct effects were found in the model with workplace physical activity outcome variable.

When past behaviour (collected at Time 1) was added to each model, the goodness-of-fit statistics confirmed overall good fit with the data for leisure-time physical activity variable (χ^2 = 15.550, df = 18, p = .624; RMSEA = .000, 90% CI: .000 to .057; PCLOSE = .918; SRMR = .021; CFI = 1.000) and total physical activity (χ^2 = 14.098, df = 18, p = .723; RMSEA = .000, 90% CI: .000 to .050; PCLOSE = .950; SRMR = .020; CFI = 1.000). The model with workplace physical activity outcome variable presented slightly worse global fit indices than the model without past behaviour (χ^2 = 19.184, df = 18, p = .381; RMSEA = .019, 90% CI: .000 to .070; PCLOSE = .795; SRMR = .024; CFI = .998), but all estimates still pointed towards a good fit of the model. Consistent with the findings of the baseline TPB model, past behaviour was a significant predictor of TPB latent constructs for leisure-time and total physical activity, whereas it was not a significant predictor of workplace physical activity. Moreover, when past behaviour was added as a predictor of prospective behaviour and TPB items, it attenuated the influence of behavioural intention in leisure-time and total physical activity models, as the path from intention to behaviour became non-significant ($\beta = -.01$, $p > .05$; $\beta = .01$, $p > .05$ respectively). However, there was a significant interaction effect between PBC and intention on leisure-time physical activity behaviour at Time 2 ($\beta_{PBCxINT} = -.60$, $p = .007$), and on workplace physical activity at Time 2 ($\beta_{PBCxINT} = -.35$, $p < .001$), indicating that higher levels of PBC and intention were associated with lower levels of behaviour. The interaction effect was non significant in the model with total physical activity outcome variables.

Furthermore, the addition of past behaviour attenuated the indirect effects of TPB latent factors on prospective behaviour, which became non-significant. Behaviour at Time 1 had also significant total effects on behaviour at Time 2 for leisure-time ($\beta = .64$, $p < .001$), workplace ($\beta = .79$, $p < .001$), and total physical activity ($\beta = .81$, $p < .001$): for every MET-hour/week increase in leisure-time physical activity at Time 1, LTPA at Time 2 was predicted to increase by .63 MET-hours/week. For every unit increase in workplace physical activity at Time 1, WPA at Time 2 was predicted to increase by .67 MET-hours/week. Lastly, total physical activity at Time 2 was predicted to increase by .70 MET-hours/week if TOTPA at Time 1 increased of one unit.

4.5.3 Longitudinal TPB models

The hypothesised model presented in Figure 4.6 was fitted to the data. Relationships between behavioural intentions, attitudes, subjective norms and perceived behavioural control were estimated according to the original TPB model at both time points. This means that all latent constructs were regressed on each other across the two time points, according to the model represented in Figure 4.6 (p. 242). The regression paths on like constructs accounted for the stability of covariances and the relative change in scores within participants over time. The item residuals of like indicators for all latent factors were also correlated to account for measurement error stability over time. The disturbance terms between attitudes, subjective norms and perceived behavioural control were allowed to covary at each time point in order to account for the contemporaneity of the relationships of the model at each time point, as suggested by Ajzen (1985).

In this paragraph are presented the results of longitudinal TPB models, which served as starting point for the MIMIC models presented in the following paragraph. Tables with standardised and unstandardised path coefficients as well as standardised disturbance terms of these models are provided in Annex A.

According to the goodness-of-fit statistics, the hypothesised longitudinal TPB model presented in Figure 4.6 exhibited a satisfactory fit with the data for leisure-time physical activity (χ^2 = 93.555, df = 88, p = .323; RMSEA = .013, 90% CI: .000 to .032; PCLOSE = 1.000; SRMR = .048; CFI = .997), and total physical activity (χ^2 = 96.528, df = 88, p = .251; RMSEA = .016, 90% CI: .000 to .034; PCLOSE = 1.000; SRMR = .048; CFI = .995). The model including workplace physical activity variables achieved a moderate fit with the data: the Chi-square test was significant (χ^2 = 120.285, df = 88, p = .013) and the standardised root mean square residual was above .05 (SRMR = .06); the RMSEA was below .05, the p value for close fit was non-significant, and the comparative fit index was about 1.0 (RMSEA = .032, 90% CI: .015 to .045; PCLOSE = .989; SRMR = .060; CFI = .997). Modification indices were inspected in search for sources of ill fit in case a theoretically viable solution was prospected. Several modification indices larger than 10 were suggested. One of the these suggested adding a path from perceived behavioural control at baseline and intention at Time 1. Another one suggested adding a feedback loop from intention at Time 1 to intention at baseline. Considering the strenght of the PBC latent factor on behavioural intention at baseline, it was plausible that this factor could have influenced directly also Time 1 intention latent factor. Hence, the path was included and the model was re-fitted to the data. The re-fitted model achieved a satisfactory fit with the data (χ^2 = 98.975, df = 87, p = .179; RMSEA = .020, 90% CI: .000 to .036; PCLOSE = 1.000; SRMR = .055; CFI = .993).

Consistent with the cross-sectional findings, past behaviour (collected at baseline) was a significant predictor of TPB latent constructs at baseline and at Time 1 for leisure-time and total physical activity models but not for workplace physical activity. The TPB model significatly predited behavioural intention at both time points across all behaviours. Across all models, the paths from perceived behavioural control and from subjective norms to behavioural intention were significant, as opposed to those from attitudes to behavioural intention. Overall, the TPB model predicted about 75% of the variance in behavioural intention at baseline, and about the 85% of the variance at Time 1 (the paths from intention at baseline to intention at Time 1 were non-significant). Behavioural intention was a significant predictor of behaviour at Time 1 for leisure-time ($\beta = .17$, $p < .005$), and total physical activity ($\beta = .21$, $p < .05$), but was not a significant predictor at Time 2, the effects being attenuated by the presence of paths from behaviour at baseline and behaviour at Time 1 to behaviour at Time 2. For leisure-time physical activity, the total effect baseline behaviour on behaviour at Time 2 was $\beta = .57$, $p < .001$, and the effect of behaviour at Time 1 on behaviour at Time 2 was $\beta = .64$, $p < .001$. For workplace physical activity, the total effects of WPA at baseline on WPA at Time 1 and on WPA at Time 2 were both $\beta = .47$, $p < .001$. For total physical activity, the total effects of behaviour at baseline on behaviour at Time 2, were $\beta = .58$, $p < .001$ and $\beta = .53$, $p < .001$. Lastly, the regression paths from TPB latent constructs at baseline to their respective factor at Time 1 were significant for attitudes, perceived behavioral control and subjective norms latent factors across all models ($\beta_{ATT} \sim .60$; $\beta_{PBC} \sim .50$; $\beta_{SN} \sim .48$, $p < .001$), except for behavioural intention. This was consistent with the fact that the theorised predicting latent factors at Time 1 (i.e., attitudes, PBC and subjective norms) accounted for more than 80% of the variance in behavioural intention at Time 1 across all behaviours.

4.5.4 Intervention effects

The effect of the intervention on TPB latent factors and prospective behaviour was tested using the longitudinal model previously fitted to the data, with the additional paths from intervention group to all TPB latent factors and behaviour at Time 1. To test for potential long-term effects on behaviour, a path was added also from intervention group to behaviour at Time 2. Following are presented and discussed the results of the longitudinal MIMIC models testing the effects of the intervention group on TPB latent factors and prospective physical activity behaviour at Time 1.

All longitudinal MIMIC model testing the intervention effects exhibited a satisfactory fit with the data with leisure-time physical activity (χ^2 = 99.841, df = 99, p = .457; RMSEA = .005, 90% CI: .000 to .028; PCLOSE = 1.000; SRMR = .045; CFI = 1.000), workplace physical activity (χ^2 = 104.865, df = 99, p = .342; RMSEA = .013, 90% CI: .000 to .031; PCLOSE = 1.000; SRMR = .031; CFI = .997), and total physical activity (χ^2 = 101.250, df = 98, p = .418; RMSEA = .000, 90% CI: .000 to .029; PCLOSE = 1.000; SRMR = .044; CFI = .999).

Standardised and unstandardised path coefficients are presented in Table 4.31. Path coefficients for the longitudinal MIMIC model predicting LTPA at Time 2Table 4.31 for leisure-time, in Table 4.32 for workplace, and Table 4.33 for total physical activity models. Standardised disturbance terms are presented in Table 4.34. The MIMIC models achieved similar results compared to the longitudinal TPB models except for the slightly smaller coefficients of the paths from TPB latent factors at baseline and Time 1, being attenuated by the direct paths with the intervention variable (coded: e-mail only = 0; e-mail plus SMS = 1).

Across all three physical activity domains, the only significant direct effect of the intervention was found with the attitudes latent factor at Time 1 (β = -.15, $p < .05$). This result suggests that the mean of the attitude latent factor of the e-mail only group was significantly higher than e-mail plus SMS group at Time 1. Nevertheless, the intervention had no significant effects on prospective behaviour, except for workplace phyisical activity at Time 1 (β = -.15, $p > .05$): the mean WPA score of e-mail only group was significantly higher than the mean score of e-mail plus SMS group. The model estimated that the difference between groups was 2.88 MET-hours/week. The intervention had no significant indirect effects on prospective behaviour at Time 2 across all behaviours.

The significant impact of intervention on the attitude latent factor remained unchanged also when other background factors were included in the MIMIC model as covariates (see Tables 7.14 to 7.19 provided in Annex A). The models controlled for gender, age, education and perceived health status background variables, which were included in the model as they showed significant differences in TPB items and behaviours at the univariate level (these factors were associated with small to moderate effect sizes). For instance, gender was included as predictor of changes in baseline and Time 2 total physical activity, because significant differences between males and females were found in these two time points. Likewise, perceived health status was included as predictor of perceived behavioural control at baseline and of attitudes at baseline and Time 1; age was included as predictor of perceived behavioural control and intention at baseline and PBC at Time 1; education was included as predictor of: PBC, workplace and total physical activity at baseline; attitudes at Time 1, and total physical activity at Time 2.

These results were consistent with those found through more traditional tests, including independent-sample t-tests that were conducted cross-sectionally with the aim to detect the magnitude of the differences between intervention groups on TPB items and physical activity outcome variables. Significant differences between groups were found in some items measuring attitudes, perceived behavioural control and subjective norms at Time 1 and Time 2. Specifically, at Time 1, there was a statistically significant difference in ATT2 item ($t_{(153)} = 2.402$, $p = .018$, $\eta^2 = .04$, $d = .39$), in PBC1 item ($t_{(153)} = 2.031$, $p = .044$, $\eta^2 = .03$, $d = .33$), and INT2 item ($t_{(153)} = 2.025$, $p = .045$, $\eta^2 = .03$, $d = .33$). At Time 2, the only significant difference was found in behavioural intention item INT3 ($t_{(129.40)} = 2.404$, $p = .018$, $\eta^2 = .04$, $d = .42$). In general, participants in the e-mail only group scored significantly higher than participants in the e-mail plus SMS group in all the aforementioned TPB items scales from a cross-sectional point of view. However, these differences were associated with small effects.

No statistically significant differences were found on physical activity scores after the intervention. Independent sample t-test did not detect significant differences in workplace physical activity behaviour ($t_{(153)} = 1.158$, $p = .249$, $\eta^2 = .01$, $d = .19$), but this might be explained by the fact that only $n = 155$ cases were utilised for the tests. Sensitivity power analysis revealed that the ‘critical t’ for the test to detect significant changes in means with that sample size, an alpha level of .05 and a minimum power of .80 was $t_{(153)} = 1.975$. Therefore, the results conducted with the SEM approach and with a sample of 361 cases were more robust in detecting significant changes in the outcome variables under scrutiny.

Table 4.31. Path coefficients for the longitudinal MIMIC model predicting LTPA at Time 2

Path	B	B 95% CI		β
Past behaviour to TPB(T0)				
LTPA(T0) to Attitude(T0)	.03**	.02	.03	.37
LTPA(T0) to PBC(T0)	.03**	.02	.04	.37
LTPA(T0) to Subjective norm(T0)	.02**	.01	.03	.19
LTPA(T0 to Intention(T0)	.00	-.01	.01	.01
TPB and future behaviour (baseline-T1)				
Attitude(T0) to Intention(T0)	.07	.06	.20	.07
PBC(T0) to Intention(T0)	.67**	.50	.84	.76
Subjective norm(T0) to Intention(T0)	.12*	.04	.20	.16
Intention(T0) to LTPA(T1)	2.53*	.14	4.93	.18
Behaviour at Time 1 to TPB(T1)				
LTPA(T1) to Attitude(T1)	.01*	.00	.02	.17
LTPA(T1) to PBC(T1)	.03**	.02	.04	.19
LTPA(T1) to Subjective norm(T1)	.02*	.00	.03	.34
LTPA(T1) to Intention(T1)	-.01	-.02	.01	-.06
TPB and future behaviour (T1-T2)				
Attitude(T1) to Intention(T1)	.15	-.04	.33	.12
PBC(T1) to Intention(T1)	.74**	.46	1.03	.75
Subjective norm(T1) to Intention(T1)	.15*	.03	.27	.15
Intention(T1) to LTPA(T2)	-.29	-1.72	1.13	-.01
Autoregressive paths				
Attitude(T0) to Attitude(T1)	.60**	.41	.78	.60
PBC(T0) to PBC(T1)	.51**	.29	.73	.47
Subjective norm(T0) to SN(T1)	.42*	.09	.75	.46
Intention(T0) to Intention(T1)	.10	-.07	.27	.08
LTPA(T0) to LTPA(T1)	.55**	.14	.76	.51
LTPA(T1) to LTPA(T2)	.44*	.12	.76	.43
LTPA(T0) to LTPA(T2)	.41**	.15	.67	.39
Intervention effects				
Group to Attitude(T1)	-.42*	-.78	-.05	-.16
Group to PBC(T1)	-.42	-.87	.03	-.12
Group to Subjective norm(T1)	-.41	-.89	.08	-.12
Group to Intention(T1)	.05	-.22	.32	.02
Group to LTPA(T1)	1.04	-4.45	6.53	.03
Group to LTPA(T2)	-3.26	-8.63	2.11	-.08

Notes: B = unstandardized coefficient, β = standardised coefficient; 95% CI is the 95% confidence interval for the unstandardized coefficient; LTPA stands for leisure-time physical activity; T0, T1 and T2 indicate the time of measurement: T0 = baseline, T1 = Time 1 (12 weeks after baseline); T2 = Time 2 (16 weeks after baseline) * $p < .05$, ** $p < .001$.

Table 4.32. Path coefficients for the longitudinal MIMIC model predicting WPA at Time 2

Path	B	B 95% CI		β
Past behaviour to TPB(T0)				
WPA(T0) to Attitude(T0)	.00	-.01	.02	.01
WPA(T0) to PBC(T0)	.01	-.01	.03	.07
WPA(T0) to Subjective norm(T0)	.01	-.01	.03	.07
WPA(T0 to Intention(T0)	-.01	-.02	.04	-.04
TPB and future behaviour (baseline-T1)				
Attitude(T0) to Intention(T0)	.08	-.04	.21	.08
PBC(T0) to Intention(T0)	.63**	.48	.79	.74
Subjective norm(T0) to Intention(T0)	.13*	.05	.21	.17
Intention(T0) to WPA(T1)	.00	-.94	.95	.00
Behaviour at Time 1 to TPB(T1)				
WPA(T1) to Attitude(T1)	.01	-.02	.03	.05
WPA(T1) to PBC(T1)	.01	-.02	.03	.05
WPA(T1) to Subjective norm(T1)	.01	-.01	.04	.07
WPA(T1) to Intention(T1)	.00	-.01	.02	.01
TPB and future behaviour (T1-T2)				
Attitude(T1) to Intention(T1)	.10	-.10	.29	.08
PBC(T1) to Intention(T1)	.94**	.64	1.24	.96
Subjective norm(T1) to Intention(T1)	.06	-.09	.21	.06
Intention(T1) to WPA(T2)	.04	-.67	.76	.01
PBC(T0) to Intention(T1)	-.76**	-1.16	-.36	-.75
Autoregressive paths				
Attitude(T0) to Attitude(T1)	.63**	.45	.81	.66
PBC(T0) to PBC(T1)	.70**	.52	.87	.65
Subjective norm(T0) to SN(T1)	.61**	.27	.95	.67
Intention(T0) to Intention(T1)	.76**	.37	1.15	.64
WPA(T0) to WPA(T1)	.45**	.27	.62	.48
WPA(T1) to WPA(T2)	.61**	..40	.82	.72
WPA(T0) to WPA(T2)	.11	-.08	.29	.14
Background factors				
Group to Attitude(T1)	-.38*	-.75	-.01	-.15
Group to PBC(T1)	-.31	.78	.17	-.09
Group to Subjective norm(T1)	-.35	.84	.14	-.11
Group to Intention(T1)	.01	.30	.32	.00
Group to WPA(T1)	-2.88*	-5.63	-.13	-.15
Group to WPA(T2)	-.19	-2.38	2.00	-.01

Notes: B = unstandardized coefficient, β = standardised coefficient; 95% CI is the 95% confidence interval for the unstandardized coefficient; WPA stands for workplace physical activity; T0, T1 and T2 indicate the time of measurement: T0 = baseline, T1 = Time 1 (12 weeks after baseline); T2 = Time 2 (16 weeks after baseline) * $p < .05$, ** $p < .001$.

Table 4.33. Path coefficients for the longitudinal MIMIC model predicting TOTPA at Time 2

Path	B	B 95% CI		β
Past behaviour to TPB(T0)				
TOTPA(T0) to Attitude(T0)	.01*	.00	.01	.21
TOTPA(T0) to PBC(T0)	.01**	.01	.02	.26
TOTPA(T0) to Subjective norm(T0)	.01*	.02	.01	.16
TOTPA(T0 to Intention(T0)	.00	.00	.00	.03
TPB and future behaviour (baseline-T1)				
Attitude(T0) to Intention(T0)	.07	-.06	.19	.07
PBC(T0) to Intention(T0)	.67**	.50	.84	.75
Subjective norm(T0) to Intention(T0)	.12*	.04	.20	.16
Intention(T0) to TOTPA(T1)	5.71*	1.22	1.19	.20
Behaviour at Time 1 to TPB(T1)				
TOTPA(T1) to Attitude(T1)	.01	.00	.01	.16
TOTPA(T1) to PBC(T1)	.01*	.01	.02	.29
TOTPA(T1) to Subjective norm(T1)	.01*	.00	.02	.21
TOTPA(T1) to Intention(T1)	.00	-.01	.00	-.03
TPB and future behaviour (T1-T2)				
Attitude(T1) to Intention(T1)	.16	-.04	.32	.11
PBC(T1) to Intention(T1)	.74**	.47	1.01	.75
Subjective norm(T1) to Intention(T1)	.15*	.02	.27	.15
Intention(T1) to TOTPA(T2)	-.07	-3.03	2.90	.00
Autoregressive paths				
Attitude(T0) to Attitude(T1)	.60**	.42	.78	.61
PBC(T0) to PBC(T1)	.54*	.33	.76	.50
Subjective norm(T0) to SN(T1)	.43*	.07	.79	.47
Intention(T0) to Intention(T1)	.09	-.08	.26	.09
TOTPA(T0) to TOTPA(T1)	.57**	.40	.74	.53
TOTPA(T1) to TOTPA(T2)	.66**	.44	.88	.76
TOTPA(T0) to TOTPA(T2)	.09	-.09	.26	.09
Background factors				
Group to Attitude(T1)	-.40*	-.77	-.03	-.15
Group to PBC(T1)	-.36	-.83	.10	-.11
Group to Subjective norm(T1)	-.38	-.86	.1	-.11
Group to Intention(T1)	.03	-.25	.31	.00
Group to TOTPA(T1)	-5.48	-15.9	4.94	-.07
Group to TOTPA(T2)	-1.11	-9.43	7.23	.02

Notes: B = unstandardized coefficient, β = standardised coefficient; 95% CI is the 95% confidence interval for the unstandardized coefficient; TOTPA stands for total physical activity; T0, T1 and T2 indicate the time of measurement: T0 = baseline, T1 = Time 1 (12 weeks after baseline); T2 = Time 2 (16 weeks after baseline) * $p < .05$, ** $p < .001$.

Table 4.34. Standardised disturbance terms for all longitudinal MIMIC models predicting behaviour at Time 2

Endogenous variable	LTPA	WPA	TOTPA
TPB model at baseline			
Attitude(T0)	.87	1.00	1.00
PBC(T0)	.87	1.00	1.00
Subjective norm(T0)	.96	1.00	1.00
Intention(T0)	.24	.25	.25
TPB model at Time 1			
Attitude(T1)	.53	.55	.55
PBC(T1)	.53	.54	.54
Subjective norm(T1)	.70	.53	.53
Intention(T1)	.15	.04	.04
Behaviour			
Behaviour (T1)	.64	.75	.75
Behaviour (T2)	.47	.37	.37

Notes: LTPA stands for leisure-time physical activity; WPA = workplace physical activity, TOTPA = total physical activity; T0 and T1 indicate the time of measurement: T0 = baseline, T1 = Time 1 (12 weeks after baseline); T2 = Time 2 (16 weeks after baseline) * $p < .05$, ** $p < .001$.

4.6 Interviews and focus groups

In the following paragraphs the results of qualitative thematic analysis of the interviews and focus groups conducted with employees are reported. First the results from employees who participated are presented. Next, findings from data collected form employees who did not participate in the MoveM8 programme are described.

4.6.1 Participants

Enrolled employees

A total of 311 invitations were sent to employees who participated in the MoveM8 programme. A total of 53 employees agreed to be interviewed; of these, 44 were interviewed individually and 11 participated in two focus groups (focus group 1, n = 6; focus group 2, n = 5). The majority of individual interviews were conducted with employees at the university campuses of Nottingham and De Montfort (n = 35). The rest of the interviews were conducted on the phone via Skype with employees working for organisations in different sectors, including a borough council in the North West of England, a multinational company and a chemical storage site in the North East, and an insurance company based in the South East. The focus groups were conducted in two workplaces located in the North East of England region, one in a company of the chemical industry and the other in a college. Consistent with the total sample of enrolled employees presented in the previous paragraphs, the majority of interviewees were female (n = 40). The mean age was 39 years (see Table 4.35), and the majority worked full time, had obtained a higher degree, and lived as a couple with kids. These results are in line with those found in the full sample (see Table 4.2).

Table 4.35. Demographics of interviewees who participated in the MoveM8 programme

	Interviews (n = 42)	Focus groups (n = 11)	Total (n = 53)
Gender			
Female	31	9	40
Male	11	2	13
Age groups*			
20-29 years	8	1	9
30-39 years	9	2	11
40-49 years	15	3	18
50-63 years	10	5	15
Intervention group			
E-mail only	22	7	29
E-mail plus SMS	20	4	24
Education level			
Higher degree	30	6	36
A level or equivalent	5	2	7
Other professional qualification	5	3	8
O-Level passes/GCSE	2	-	2
Workplace type			
Universities	35	-	35
Colleges	1	6	7
Service companies (SMEs)	4	-	4
Chemical companies	1	5	6
Borough councils	1	-	1
Work status			
Full time (80-100%)	33	11	44
Part-time (50-70%)	7	-	-
Part-time (25%)	2	-	-
Family status			
Single, with no kids	12	1	13
Single, with kids	2	-	-
Couple, with no kids	13	5	18
Couple, with kids	15	5	20

Notes: Mean age for individual employees: 41 years (SD = 11, range: 21 – 63); Mean age for males = 46 years (SD = 11, range: 28 – 62); Mean age for females = 39 years (SD = 11, range: 21 – 63); Mean age for focus group participants: 44 years (SD = 11, range: 25 - 60); Mean age for males = 39 (SD = 11.2, range: 25 – 53); Mean age for females = 45 (SD = 9, range 33 – 60).

Non-enrolled employees

Non-enrolled employees were recruited from a total population of 76 potential participants who started the enrolment process for the MoveM8 programme in 2009-2010, but did not complete it. Of these, 11 agreed to be interviewed and two were excluded because they were not eligible. All interviews were conducted face-to-face or over the phone. Face-to-face interviews were conducted with seven participants from universities. Two were conducted over the phone with employees from companies. The majority of interviewees were female; the mean age was 36 years for both male and female participants. In Table 4.36 relevant demographic information is summarised.

Table 4.36. Demographics of interviewees who did not enrol in the MoveM8 programme

Characteristic	n
Gender	
Female	6
Male	3
Age groups	
20-29 years	1
30-39 years	3
40-49 years	3
50-63 years	2
Workplace type	
Universities	7
Service companies (SMEs)	2

Notes: Mean age for non-enrolled employees: 36 years (SD = 11, range: 22 – 51); Mean age for males = 36 years (SD = 14, range: 25 – 51); Mean age for females = 36 years (SD = 11, range: 22 – 50).

4.6.2 Analysis

The quotations and comments that follow derive from verbatim transcriptions but are reported corrected *ex post* for grammar consistency. Words or parts of sentences contained in brackets "[i.e., the MoveM8 programme]" denote additional text added to better explain what was 'not said' or made reference to a previous part of the discussion.

Analysis of the transcripts from all focus group sessions and interviews allowed to identify recurring themes organised around the following clusters two clusters: “reasons for participation” and “reasons for non-participation” in the MoveM8 programme. Within each of these two clusters, themes were organised according to three main topical areas: 1) “reasons related to the personal sphere”; 2) “reasons related to the characteristics of the programme itself”; 3) “reasons related to external factors”. Under personal sphere cluster were included all themes that addressed aspects associated with personal characteristics, needs, beliefs, perceptions and concepts of the self. Under the characteristics of the programme itself were included themes that described reasons associated with some aspects of the programme that motivated employees to sign up. Themes included in the “reasons related to external factors” category were related to external factors or motivators, under the influence of the others, such as signing up because another person recommended or joined the programme, or because the boss wanted so. Each cluster had sub-clusters corresponding to the most recurring and relevant themes emerged from the focus groups discussions and interviews.

Within the cluster “reasons for participation”, the themes emerged from focus groups and individual interviews conducted with enrolled employees as described above. The results of the focus groups are presented separately from those of the interviews, but recurring and co-occurring themes are reported with the same title. Excerpts from the sessions that best reflect the recurring themes are presented below.

Lastly, the cluster “reasons for non-participation” comprises the themes emerged from individual interviews conducted with employees who did not participate in the MoveM8 programme. A schematic representation of the themes emerged from focus groups and interviews are presented in Table 4.37.

4.6.3 Reasons for participation

4.6.3.1 Focus groups

Within the cluster "reasons related to the personal sphere", two themes were identified: 1) "*Weight management*", and 2) "*Motivation*". For the cluster "reasons related to the programme itself", the theme that emerged was "*Reminders*". No theme in the cluster "external reasons" explicitly emerged from the focus groups.

Reasons related to the personal sphere

Weight management. The predominant theme that clearly emerged from both focus group discussions about the reasons for participating in the MoveM8 programme was related to weight management, in particular to the "need to lose weight". All focus group participants during the discussions mentioned this aspect, providing examples from personal experience with being overweight or obese. Losing weight was intended mostly as a need to improve physical appearance in relation with important others, but was also linked to concerns about general fitness and wellbeing. The theme of weight management emerged from both male and female participants. The following quotations best describe the theme of weight management:

> "I decided to have a go at this MoveM8 because I needed to lose some weight and improve my fitness."

> "Everybody in my family is healthy and fit and sporty except myself. So everything I was getting then, [it was] to increase my fitness level altogether. So I went to the MoveM8 because it was something I could do at work, read through the lunch hour, you know."

> "I'm very much aware that I need to lose some weight. Ehm... I was also diagnosed with a heart condition and although I haven't been advised to lose weight with that, I thought it would probably help if I did [sign up]."

Motivation. The second most recurring theme across the two focus groups was linked to the need to get motivated. Participants said they wanted to get motivated and to receive a "*kick in the backside*", to engage in more physical activity and pursue the objective of being fitter and stay healthy. Illustrative examples of this theme are the following:

> "I spend most of my days at a desk. So I joined the programme to get a bit more motivation to do more exercise. And that's it I think, basically."

> "I've always been keen to sort of promote health opportunities for staff. Plus, on a personal level, I just needed some motivating to do a bit more exercise and, well, do what I know I should do and I don't do very well."

Reasons related to the characteristics of the programme

Reminders. Associated with the previous themes, was the reminder function of the programme. E-mails were considered incentives to help remind employees about their physical activity. Some participants said that they joined the programme, explicitly because they liked the idea of receiving constant weekly reminders that would have helped them achieving their goals:

> "I wanted to get fitter and lose some weight and by getting the e-mails that we got it would sort of motivate me to do that all the more."

> "I did this [the MoveM8 programme] because it would give you the incentive that you get an e-mail on a weekly basis, something that I haven't been experiencing before. We also got it about probably at the same time as this came out, so it came quite... to adding quite nicely to the exercise and getting prompted for the difficulty as well."

> "I did it [I signed up] because I knew I needed something to make me think about it all the time."

4.6.3.2 Individual interviews

The analysis of the transcripts of all 42 individual interviews revealed the following themes, organised around the clusters “reasons related to the personal sphere” and “reasons related to the characteristics of the programme”. Within the cluster “reasons related to the personal sphere”, four major themes emerged: 1) “Need to be more physically active”, 2) “Motivation”, 3) “Curiosity”, and 4) “Weight management”. For the cluster “reasons related to the programme itself”, the theme that predominantly emerged from the majority of respondents were in order of importance: 1) “Ease of use”, 2) “Reminders”, 3) “Interestingness”. For the cluster “reasons related to external factors”, two themes emerged: 1) “Promotion” and 2) “Collegiate spirit”.

Reasons related to the personal sphere

Need to be more physically active. About half of the participants, acknowledged that they needed to do more physical activity and indicated this need as their main reason for signing up for the programme. Many of them explicitly said they contemplated the idea of getting more physically active as their type of job was sedentary. The following four quotes best describe the theme:

> “I needed to do it. It’s not just something that, you know, was easy for me. I wasn’t doing enough for long before then. Well, [I wasn’t doing any] structured sort of exercise if, you like. So I thought that it was just to have a good kick-start to do it, you know.”

> “I think the main reason was because I spent my working day stationary, I mean, [I have] quite a stressful job and I won’t be doing anything other than sitting down at my desk. I didn’t really want to go for a walk… You know, things like that. [So I wanted] to do more... ehm, what’s the word… naturally, without having to go to the gym, just... increase my normal everyday movement.”

> "[I enrolled] because I used to go to the gym regularly, and then I stopped that habit, and I kind of realised after a year that I ought to do something more, so that's why I think."

> "I've decided to enrol because I sort of thought… the messages were right, you know, 'don't just sit at your desk'. You can show you can get up and go for a walk instead of surfing on the internet or, you know, and so I thought… I knew I wanted it, well, I knew I should do more exercise."

Motivation. In relation to the theme of doing more activity came the second strongest theme that emerged from 14 employees: motivation. In the same way as in the focus groups, interviewees said they needed a push, a "kick in the backside", to get their own activities going. They identified in the programme a source of motivation and considered it as a reason for enrolling in the MoveM8. The following excerpts best describe the connection between the need of motivation and the decision to join in the programme.

> "I need motivation... which is why I joined. Yes it is important. The older I get the more important it feels."

> "To really try and kick start my exercise routine again, really. But it was really to just try and kick start, you know, the motivation in it again, getting more focus back."

> "I thought it was worthwhile. I'm aware that I need to exercise more and I thought this was a way of doing that. It would motivate me to do it, which was the idea of the programme."

> "I needed a bit of a push, just needed a bit of a kick on the backside I suppose to make to start thinking about it."

> "I know, because I thought it would just give me a kick on the backside and thought get me doing more than I already knew I should be doing, basically."

Curiosity. A minor theme emerged from 10 interviewees was “curiosity”. This theme conveys the idea that participants enrolled because they were curious about it or because they wanted to *see* how it looked like. A few interviewed employees mentioned also that they wanted to compare themselves with other participants, even though they were already highly active and if they did not need particular motivation to do more physical activity.

> “I decided to take part because I received the e-mail and I thought it would be interesting to see what it was all about.”

> “[I enrolled] basically because it was asking for information about people’s activity levels and… I was sort of curious as how they were doing benchmarking, if you like, on people’s fitness levels and what sort of criteria they were using to measure what we’re doing and really to see where I was in terms of my own level of physical fitness and ability.

Weight management. Consistent with the findings of the focus groups, the theme of weight management emerged also from the interviews, but concerned only a small number of female participants, who indicated that they enrolled in the programme mainly because they wanted to lose some weight, as the following two excerpts describe:

> “Because I wanted to lose weight and so I already did do exercise, but I knew that I needed to do something in addition, because I was doing the same things and I just thought it’s not having as much effect anymore, so [I joined the programme].”

> “I was overweight at the time - I still am anyway, so... it was the fact that I knew that at the end of the programme I would probably feel better about myself and I would lost a couple of pounds and I mean that 5% weight loss its benefits are have been well documented. So for me that was the motivating factor.”

Reasons related to the characteristics of the programme

Ease of use and accessibility. The strongest theme related to the programme itself was associated with the fact that it was easy to do, accessible and available. Many participants mentioned the ease of use and accessibility as a motivator that convinced them to subscribe. The following three quotes best describe the idea of simplicity and ease of use of the programme:

> "It just seemed like something that was a good idea. It didn't really take much of my time, it was simple to do. To actually go out of my way and do it, it was easy, really."

> "… The other key thing of course was that it was online. So it was immediately accessible and available... and I could work with the idea of getting the e-mail every now and then, to kind remind me about what I should be doing and to keep me kind of focused on it. And so I think it was primarily the accessibility, the ease of use of the information as it was provided."

> "I think it came through and it all looked quite simple and there was nothing intimidating about it. It was just... To me it was like straightforward advice in the most common sense. But I kind of like... Well, the reason my gym works now is because I make appointments to go and I stick to it. And so anything to do with getting reminders through, if you get an e-mail through, and I can actually set a programme, then I find that a lot more motivating."

Reminders. Another key theme related to the ease of use and accessibility concerned the use of reminders. This theme was also associated with the motivation theme, since reminders were intended as "extra incentives" useful for "making them think" about getting more physical activity. Illustrative examples of this theme are the following:

> "I subscribed because I thought kind of getting a regular kind of prompt to kind of be doing stuff would be helpful to make me do stuff."

> "I was in the process of thinking I should be doing more exercise anyway, so I thought it would be a handy thing to have coming to me to remind me to do that."

> "To get the reminders, because if you're sat, if you are in a lunch break and you're sat at your desk just on the Internet and you're not moving and you're eating something that's not that good and then you get a reminder and it's just: 'have a walk!', or something. Straight away there is a trigger in your mind and you think: 'yeah, that's right, I can do that!'."

> "I remember the text messages having... You know, being constantly attached to my phone… I remember seeing that [message] and thinking: 'maybe that would work, maybe that would kind of get me off my butt and doing stuff'."

Interestingness. Lastly, a smaller but indicative theme was related to the fact that the programme seemed attractive and interesting. Some interviewees indicated that they felt attracted by its "look and feel" when they received the e-mail invitations or saw the posters to enrol. Some employees said "*I just thought it looked interesting when it came through on the e-mail*", and "*I did see posters around and they were very eye catching and sort of encouraging. So, really, I did like that. I thought it was a very good way of drawing people in*." The concept of interestingness might be also linked to the previous theme of receiving reminders, which was perceived as an attractive characteristic of the programme. The next excerpt best describes the connection between interestingness and the ideas of receiving prompts:

> "It just looked quite interesting to you know, the idea of receiving little messages to tell you to do things and I was just interested in participating. I suppose [I was interested in] the idea of being told what to do, you know, being sent messages by people telling you to do things... and I thought that it might be interesting."

Reasons related to external factors

Recommendation. Themes related to external factors were not as common, but did emerge and showed that some participants enrolled after being recommended by a colleague or a friend: "*It was a friend that recommended it last time we see: she had seen the posters and recommended it to me, because she knew I might have been interested*".

Collegiate spirit. A couple of interviewees mentioned also that they enrolled because they wanted to help the research and felt responsible for partaking to do a favour to a fellow research institution. Two illustrative examples are the following:

> "Mainly because, I think, this sort of research can't be done unless people take part in it."

> "Well, we do a lot of work with other universities anyway, you know, so if Yyyyy e-mailed us, it would be good to help and vice-versa. Well, if they need people to do it... You know, we... we try to help... universities generally try and help each other with stuff and… So I felt a little responsibility to do that."

4.6.4 Reasons for non-participation in the MoveM8 programme

The reasons for non-participation in the MoveM8 programme are described below. Similarly to the reasons for participation, themes were grouped according to the three clusters "reasons related to the personal sphere", "reasons related to the characteristics of the programme", and "reasons related to external factors". Under the first cluster one theme emerged: "*Living a busy life*"; under the cluster "characteristics of the programme", two themes emerged: "*Not relevant*" and "*Negative relationship with technology*"; within the cluster "external factors", the theme was "*Lack of follow-up*".

Reasons related to the personal sphere

Living a busy life. The strongest theme that emerged from almost all interviewees was "living a busy life" at the time when the MoveM8 was launched. This theme was associated with lack of time, dictated by work and personal life, resulting in their perceived impossibility of following-up with the tasks required for enrolling in the programme (i.e., the baseline assessment). Four illustrative examples to support this theme are:

> "I didn't sign up or I didn't do the programme for any other reason than simply due to constraints on my time and difficulties on my time, otherwise I think I would have gladly welcomed the participation. I work full time, and I've issues with my personal life, so I didn't really have a huge amount of time to do any sort of things..."

> "I had a lot of stuff going on at that time and I was getting a lot of the e-mails and I was writing on my thesis and I think it just got on the stage where I just didn't open the e-mails. I don't think I've opened any of them."

> "We used to get e-mails through about enrolling and then when I clicked on it, it just looked like it would be too time consuming. It was one of those things that had been pushed right down to the bottom of the priority list, really."

> "I work full time, I've got three children, my husband goes to works nights, so it's just... I don't have time to really do anything."

Reasons related to the characteristics of the programme

Negative relationship with technology. Another important theme was linked to the characteristic of the programme (i.e., being technology-based), but also included a personal dimension, as it was associated with the personal conflicting or difficult rapport and experience with technology. A participant mentioned they had limitations with the use of a new mobile phone, which was deemed to be the cause of a possible drop out. An illustrative example of the issue is the following:

> "I can remember trying to sign up, because I didn't get actually signed up, that's what [happened]. And then I changed my phone after that, which is probably why I didn't get... if you had sent me stuff I wouldn't have had it because I didn't use the other phone. […] I sort of went round in circles with my phone, it didn't seem to do anything or get anywhere and I gave up, really. I just kind of lost patience with the technology rather than [with] the programme."

Not relevant. Another theme that emerged from one third of the interviewees and was associated with the realisation that the programme was not dedicated to them. Interviewees thought they realised they were already doing enough physical activity as part of their daily routine and they did not need to be motivated to do more so they did not follow through. Two examples that best represent this discussion are the following:

> "I just decided it wasn't worth my while because I cycle fifteen miles a day so, you know, I probably couldn't do much more exercise anyway. I've got my own exercise routine."

> "I would have got it, get excited and thought, 'no, it is not appropriate'. I thought it wasn't aimed at me. I didn't need any motivation."

Reasons related to external factors

Lack of follow-up. Independent from the characteristics of the programme and from participants' sphere included reasons related to external factors influencing negatively the enrolment process. The lack of follow-up emerged from two interviewees working for the same organisation. Participants independently mentioned the fact that their boss at the time asked them to enrol and that they started the enrolment process. They remembered signing up to the MoveM8 and they also recalled having seen the posters at their workplace, but the employer "*didn't really get involved to an extent*". One interviewee said that they did not conclude the enrolment because they did not receive any information after they signed up, and the employer did not provide enough information to them: "*I remember signing up to it, but then, once I signed up to it I didn't really hear anything else about it, so I didn't know really what it was about or anything*". Because of this lack of follow-up, the other interviewee joined an alternative provider (i.e., a local gym), that helped them achieve their need to become more physically active.

Table 4.37. Schematic representation of the themes emerged from interviews and focus groups

Reasons for participation	Reasons for non-participation
Personal sphere	*Personal sphere*
Weight management	Living a busy life
Motivation	
Need to be active	
Curiosity	
Programme characteristics	*Programme characteristics*
Reminders	Negative relationship with technology
Ease of use and accessibility	Not relevant
Interestingness	
External factors	*External factors*
Recommendation	Lack of follow-up
Collegiate spirit	

CHAPTER FIVE DISCUSSION

CHAPTER OUTLINE

This dissertation had three objectives. The first was to test the predictive utility of the Theory of Planned Behaviour (TPB) in a sample of employees who participated in a technology-based and theory-based intervention (the MoveM8 programme). The second was to test the effect of the intervention on TPB outcomes and physical activity behaviour in the domains of leisure-time, workplace physical activity, and total physical activity. The third objective was to examine the reasons for participation and non-participation in the MoveM8 programme. In this chapter, the results are discussed in function of these three objectives and in relation to relevant literature and makes recommendations for future research. This chapter also includes a discussion of the findings in the context of the study limitations.

5.1 Sample characteristics and interpretation of results

Employees who participated in the MoveM8 intervention were predominantly female, in good health, with higher education degrees and highly active. Males were significantly more active than women and this was consistent with findings reported in the physical activity research literature (e.g., Crespo et al. 1999; Plotnikoff, Mayhew, Birkett, Loucaides, & Fodor, 2004) and with WHO official data (WHO, 2011c). Furthermore, the fact that participants were more females then males, that they were highly educated, and whose perceived health status was good, was consistent with findings reported in literature reviews about participation in workplace health promotion programmes (Kaewthummanukul & Brown, 2006; Robroek et al., 2009).

The sample included in the quantitative analyses represented a wide variety of organisations, including SMEs, academic institutions, and private companies. It has to be acknowledged that the majority of the sample came from two universities (University of Nottingham and De Montfort University). However, potential differences among workplaces (i.e., clustering effects) were inspected using ANOVA tests and intra-class correlations. Small significant effects were found only in workplace physical activity and total physical activity variables collected at Time 2. The effects were small in size and were associated with small intra-class correlations and were controlled for by using robust estimators, as implemented in software used for SEM analyses (Mplus). Therefore, it can be concluded that the results could be generalised to a population of employees with similar characteristics in terms of demographic composition.

The sample of interviewed participants was representative of the population of MoveM8 participants. The purposive sampling strategy appropriately respected the composition of the sample and also achieved maximum variation.

5.2 Objective one: predictive utility of the TPB

Consistent with the research hypothesis and with the literature, findings reported in Chapter 4.5 supported the utility of TPB as theoretical framework for examining and predicting the socio-cognitive determinants of employees' intentions to engage in physical activities and in physical activity behaviour. The TPB model significantly predicted intention to engage in physical activity across domains and predicted prospective total physical activity behaviour and physical activity in the leisure-time domain. However, the TPB model did not significantly predict physical activity in the workplace domain. In the following paragraphs the results are further discussed.

5.2.1 TPB model and the prediction of behavioural intention

Analyses of the cross-sectional structural models showed that attitudes, subjective norms and perceived behavioural control accounted for about 84% of the variance in behavioural intention in engaging in physical activity at baseline and about 75% of the variance in intention at Time 1 across domains. These results were confirmed in the longitudinal models, where the TPB accounted for 75% of the variance in behavioural intention at baseline and about 85% of the variance at Time 1, in the model with leisure-time physical activity outcome variable, and 96% of the variance in workplace and total physical activity. These results represent a great explained variance than what is reported in meta-analyses about TPB in the physical activity domain within a general population (Godin & Kok, 1996; Hagger et al., 2002b; Hausenblas et al., 1997; Symons Downs &

Hausenblas, 2005a). In fact, as previously mentioned in the background chapter, the TPB components explained approximately 40% of the variance for intention in cross-sectional comparisons (e.g., Armitage & Conner, 2001). These results derive from cross-sectional studies, but a recent paper by Plotnikoff and colleagues, which included a 15-year longitudinal comparison, reported slightly smaller estimates (29% of the variance explained by PBC and other TPB variables in a full longitudinal model) for the prediction of behavioural intention (Plotnikoff et al., 2012).

The findings of this dissertation related to the amount of variance explained in intention were to some extent aligned with results reported in other cross-sectional TPB studies conducted in the workplace. For instance, Blue and colleagues reported that perceived behavioural control explained 61.7% of the variance in intention among blue collar workers (Blue et al., 2001), whereas the study by Biddle and colleagues, who investigated the social-cognitive determinants of physical activity among a university population, found that the best predictors of intention to exercise were attitude, perceived control, benefits and self-efficacy for women, but only attitude for men (Biddle et al., 1994). Godin and Gionet (1991) found that habit ($\beta = .44$, $p < .001$), perceived barriers ($\beta = -.281$, $p < .001$), and attitude ($\beta = .207$, $p < .001$) were the strongest predictors of physical activity among employees of an electric power commission. The proportion of variance explained by these variables in intention was 41.4% (Godin & Gionet, 1991).

A possible explanation of the high estimates of regression coefficients might involve a methodological aspect: the use of latent factors as measure of TPB constructs, instead of single indicators or composite scores. Composite scores are usually computed as means or sums of single indicators, when and if these achieved good reliability and internal consistency (Francis et al., 2004; Ajzen, 2006). This might have resulted in inflated standardised estimates of path coefficients, as some specialised literature suggests: the use of latent factors might be associated with biased (inflated or deflated) estimates of regression coefficients, depending on the measurement error, but the direction of the bias is not known a priori (Kline, 2005). Conversely, using single indicators or composite scores might result in overestimation of the relationships between the variables and in findings that are significant because the measurement error is not accounted for (Kline, 2005). Meta-analyses of TPB studies involving physical activity evaluation often rely on single indicators (e.g., Hagger & Chatzisarantis, 2009; Hagger et al., 2002b), for these methods aim to combine results across different studies. Furthermore, the utilisation of single indicators or composite scores is a commonly followed procedure and is one of the recommended approaches for TPB analysis (Francis et al., 2004; Ajzen, 2006) when researchers need to examine the relationships between variables in the domain of multiple regression analysis or path analysis (Hankins, French, & Horne, 2000). One of the limitations of composite scores approach is that the measurement error associated with each indicator is not taken into account when a score is created out of a set of indicators. Furthermore, by using single indicators the assumption of unidimensionality of the TPB constructs is imposed. Unidimensionality of the TPB constructs is a core tenet of the theory proposed by Ajzen and Fishbein, but it still remains an open discussion point in some TPB literature (Hankins et al., 2000). For example, some studies questioned the unidimensionality of the concept of perceived behavioural control (e.g., Sparks, Guthrie, & Shepherd, 1997; Trafimow, Sheeran, Conner, & Finlay, 2002), with and in relation to the notions of self-efficacy and controllability. In this study, latent factors were used in place of single indicators because one of the nature of the data (i.e., some items presented some problems of internal consistency and reliability, which needed further elaboration using a latent structure), and because of the type of analytical approach used (i.e., two step approach combining CFA and structural models). It is likely that if multiple regression or path analysis with single indicators for each TPB variables were used, different results would have appeared.

5.2.2 The role of perceived behavioural control

In the present study, PBC was found to be the strongest significant predictor of intention, followed by subjective norms, while attitudes were not a significant predictor of intention. A possible explanation for the large estimated effect of the TPB model in predicting intentions and behaviour could be represented by the strong effect of perceived behavioural control on intentions. In fact, within the theorised predictors of behaviour, perceived behavioural control was the strongest predictor of behavioural intention, accounting for more than 70% of the variance in that variable across all models. These results confirm and support the important role of PBC in the TPB model, as it has been thoroughly discussed in the TPB literature (e.g., Ajzen, 2002; Armitage & Conner, 2001; Sheeran, Trafimow, & Armitage, 2003). Similar to the findings of the present investigation, Armitage (2005), in a study testing the TPB in a 12-week longitudinal study, found that PBC was the main predictor of intention and behaviour among an adult population. Similar findings are also reported in TPB studies applied in the workplace context. For example, Biddle and colleagues found that the best predictors of intention to exercise the employees who participated in their study were attitude, perceived control, benefits and self-efficacy for women, and attitude for men. The predictors of physical activity for women were intention and self-efficacy, and for men intention and attitude (Biddle et al., 1994). Godin and Gionet (1991) found that perceived barriers (which are related to perceived behavioural control, as they are associated with control beliefs and power strength), attitudes and past behaviour (represented by habit) were the strongest predictors of intention to engage in physical activity (Godin & Gionet, 1991).

The large, significant effect of PBC in this sample of employees corroborate the results reported in a systematic review by Kaewthummanukul and Brown (2006) about participation in physical activity among employees. As previously mentioned in the background chapter, the authors discovered that self-efficacy and ‘personal ability to perform’ physical activity were the best predictors of participation in physical activity among the target population (Kaewthummanukul & Brown, 2006). Personal ability to perform and self-efficacy are concepts very close to perceived behavioural control. In general, the significant predictive role of PBC means that employees with higher perceived control on their behaviour developed more positive intentions towards that behaviour, and were more likely to engage in it than others with low levels of PBC.

The non-significant contribution of attitudes in the TPB model is unusual, and no meta-analyses published to date reported such a large contribution of PBC to intention and a non-significant contribution of attitudes in the TPB model. However, Ajzen and Fishbein suggested that some constructs might be a non-significant predictor of intention and this might depend on the sample (Ajzen, 1991; Ajzen & Fishbein, 2010). For instance, in the study by Blue and colleagues, who tested the TPB in a population of blue-collar workers, reported that subjective norms was not a significant predictor of intention (Blue et al., 2001), whereas attitudes and PBC were found significant predictors of intention.

To check whether the non-significant effect of attitudes was due to the large effect of PBC, the PBC-intention path was fixed to zero, as done in Hagger and colleagues' study, in which subjective norms was not found to be a significant predictor of intention (Hagger et al., 2001). Excluding the effect of PBC on intention restored the significance to the path coefficient from attitudes to intention ($\beta = .44$, $p < .001$). This suggested that PBC alone reduced the impact of attitudes and accounted for most of the variance in behavioural intention. The non-significant influence of attitudes on intentions might also be explained by the fact that attitudes towards the behaviour might not be as influential as expected and as the other constructs postulated by the theory within a sample of employees, whose physical activity behaviour might be influenced more by their perceived control over the behaviour, rather than their attitudes.

The important role of PBC in predicting intentions and indirectly influencing behaviour might be explained by the fact that employees often see beliefs associated with perceived behavioural control (e.g., time constraints, social commitments, workload, etc.) as important barriers that hinder the possibility to engage in physical activity, as reported in the literature (e.g., Kaewthummanukul & Brown, 2006; Kruger, Yore, Bauer, & Kohl, 2007).

5.2.3 TPB model and the prediction of behaviour

Both cross-sectional and longitudinal TPB models provided evidence to support the predictive utility of the theory with regards to the domains of leisure-time (LTPA) and total physical activity (TOTPA). However, the TPB model did not significantly predict workplace physical activity (WPA). Overall, in cross-sectional models, the behavioural intention-behaviour paths were all significant, and the TPB model contributed to about 14% of the variance in leisure-time physical activity (LTPA), and 12% of the variance in total physical activity (TOTPA) at Time 1, and to about 7% of the variance in leisure-time physical activity (LTPA) and 11% of the variance in total physical activity at Time 2. Moreover, in these models, perceived behavioural control exerted also significant indirect effects on prospective behaviour in the leisure-time ($\beta = .27$, $p < .05$) and total physical activity domains ($\beta = .25$, $p < .05$).

This was not the case for workplace physical activity, which was not significantly predicted by the TPB. This is not unusual, as other TPB-based studies found no connection between intention and behaviour (e.g., Jones, Sinclair, Rhodes, & Courneya, 2004; Reger et al., 2002). It has to be noted that this variable was not significantly associated with any of the TPB variables at baseline and in the other two time points. Moreover, as the standardised disturbance terms indicated in the models showed, the variance unexplained by the TPB factors was 100% in baseline and Time 1 models. This indicated that many external factors might have explained that behaviour, but workplace physical activity was independent from any attitudes, perceived behavioural control, subjective norms and behavioural intention towards it.

Another possible explanation for this finding is that on average, workplace physical activity level was very low at baseline and remained low throughout the intervention, with small but significant improvements after the intervention (as it will be discussed later).

5.2.4 Past behaviour vs. prospective behaviour

This study also contributed to the advancement of the knowledge on the role of past behaviour in the context of the TPB. Within the domains of workplace and leisure-time physical activity, past behaviour accounted on average for the 50% of the variance in prospective behaviour across domains at baseline, and for more than 65% for the variance at Time 1. These results are consistent with Hagger, Chatzisarantis and Biddle's

(2002) and Hagger and Chatzisarantis' (2009) meta-analyses of TPB studies integrating self-determination theory. These authors found that past behaviour accounted for 55% of the variance in prospective behaviour (Hagger & Chatzisarantis, 2009; Hagger et al., 2002). For instance, Hagger and colleagues (2002) reported in their review that, across selected studies, past behaviour was a significant predictor of behaviour (β = .55), intention (β = .37), attitude (β = .39), subjective norms (β = .05), and PBC (β = .23). Moreover, in Hagger et al.'s (2001) study, past behaviour accounted for 37% of the variance in prospective behaviour (Hagger, Chatzisarantis, Biddle, et al., 2001).

The strong and significant paths from past to prospective behaviour reduced the impact of the other variables in the model, attenuating or cancelling the effect of behavioural intention on prospective behaviour for the two aforementioned domains. These results were consistent with findings reported in the literature (e.g., Brickell, Chatzisarantis, & Pretty, 2006; Hagger, Chatzisarantis, & Biddle, 2001; Hagger et al., 2002; Hagger, Chatzisarantis, Biddle, et al., 2001; Norman, Conner, & Bell, 2000; Sheeran et al., 1999).

A possible explanation for the insignificant effect of behavioural intention when controlling for past behaviour could be due to the small effect of behavioural intention on behaviour, which might reflect a lack of volitional control over the behaviour. As suggested in Armitage and Conner's meta-analysis: "Under conditions where behavioural intention alone would account for only small amounts of the variance in behaviour (i.e., where there are problems of volitional control), PBC should be independently predictive of behaviour" (Armitage & Conner, 2001, p. 473). This might have been the case, when doing work-related physical activity is beyond the control of employees, as many different factors can impact on that measure, independent from positive attitudes towards the behaviour and behavioural intention.

Another possible explanation could be due to the significant interaction between PBC and intention at baseline TPB models predicting leisure-time behaviour at Time 1 and workplace physical activity behaviour at Time 2. Therefore, lower level of behavioural intention might have been dependent on PBC and hence reducing the impact of each single variable on the outcome. However, the interaction was found only with the domain of leisure-time physical activity.

An alternative explanation for the weak intention-behaviour path in workplace and leisure-time physical activity domains could be due to the time lag between assessments and to the influence of many other external factors not included in the model, as testified by high values of disturbance terms. Moreover, as Ajzen (1985) suggested, the prediction of the TPB model is most successful when the time lag between two assessments is short (Ajzen, 1985; Ajzen & Fishbein, 2010).

5.2.5 TPB measurement properties

From a methodological point of view, longitudinal CFA measurement models showed that each TPB constructs were measured the same way over time, offering satisfactory results in terms of reliability, construct, convergent and discriminant validity over time. Nevertheless, the hypothesised cross-sectional measurement models, within a CFA approach, estimating all latent factors together through their respective indicators (three for each latent factor), revealed some issues in terms of reliability and validity, in particular for subjective norms latent factor. Also the estimates for internal consistency showed that subjective norms were not reaching acceptable thresholds (average Cronbach's alpha = .49). The issue of low reliability in subjective norms has been reported and discussed in the literature (e.g., Chatzisarantis et al., 2007; Courneya & McAuley, 1995), and it might be considered a limitation of the TPB itself. This also means that the three indicators (i.e., questions) chosen to assess social norms, in accordance to the guidelines for TPB survey development proposed by Ajzen (2006a), and according to the results of the pre-test (with a convenience sample of employees) were not perceived the same way across respondents in the full sample. This is a limitation of survey research since the validation of a survey instrument is usually based on a small sample, which might result being different from the rest of the population. The presence of problematic items might also imply that the measures were not well developed or that the established criteria and cut-off points for internal consistency (i.e., Cronbach’s alpha larger than .70) used for retaining or parcelling TPB items might not be sufficiently accurate for establishing the reliability of a scale (Sijtsma, 2008).

From factor analysis emerged another problem with the TPB survey instrument: some indicators loaded on multiple factors (cross-loadings). The presence of cross-loadings between indicators of different factors is not unusual in the CFA literature, but it has to be justified by the underlying theoretical model (e.g., Brown, 2006). In this study, the “problematic” indicators were removed, as no viable and theoretically sound alternatives could be justified, since attitudinal indicators were required to measure an attitudinal latent factor, as postulated by the theory and by the guidelines for TPB survey development (Ajzen, 1991, 2006a). Cross-loadings might also reflect a different factorial structure, which might result in including first- or second-order latent factors or in reducing the number of expected factors. For instance, some studies investigated the measurement properties of some specific TPB constructs, identifying multidimensional properties in constructs such as PBC, with regards to the concepts of controllability and self-efficacy (Ajzen, 2002; Sparks et al., 1997; Terry & O’Leary, 1995; Trafimow et al., 2002), or with regards to affective attitude (Kraft, Rise, Sutton, & Røysamb, 2005). Ajzen (2002) recognised that the dimensions of PBC, controllability and self-efficacy could be represented by higher order factor analysis. However, he also concluded that a unique variable could be “depending on the purpose of the investigation, a decision can be made to aggregate over all items, treating perceived behavioural control as a unitary factor, or to distinguish between self-efficacy and controllability by entering separate indices into the prediction equation” (Ajzen, 2002, p. 680). The analyses reported in the previous chapter provide some evidence supporting the argument against the unidimensionality of TPB constructs as it was previously outlined (Hankins et al., 2000): not only TPB constructs might not have been well identified by unique latent factors as expressed by direct items, but these direct items also showed to pertain to different latent factors not explicitly postulated by the original TPB model (Ajzen, 1991).

The estimation and evaluation of TPB measurement properties (using factor analytic approaches) seems to be infrequent in the literature, even though it has been suggested in the survey development TPB literature (Ajzen, 2002, 2006a; Francis et al., 2004). There are some studies that investigated possible extensions of the TPB measurement model through a first- and second-order CFA (e.g., Hagger & Chatzisarantis, 2005), and some applied a confirmatory factor analytic approach in evaluating the measurement properties of a TPB survey instrument before investigating the relationships between the variables postulated by the theory (e.g., Åstrøm & Nasir, 2009; Chatzisarantis et al., 2007; Fen & Sabaruddin, 2009; Gretebeck et al., 2007), as it was also done in this dissertation. This is however not common practice in TPB and physical activity studies. In most cases, full structural models or path analytic models are reported and results are described without explicitly evaluating the measurement structure. As earlier mentioned, the results of full SEM models with latent factors can be different from those obtained with traditional multiple regression or path analytic techniques because of the inclusion of measurement error and of the latent factor structure. Failing to describe the measurement model might have implications on the estimated regression coefficients in the structural model (Brown, 2006). More research is needed in this direction, so that more reliable and valid TPB measures could be developed and so that more accurate estimates of the relationships between the postulated constructs could be established.

5.3 Objective two: intervention effects

The second objective of this dissertation was to test the effects of the MoveM8 intervention on TPB constructs (i.e., attitudes towards the behaviour, subjective norms, perceived behavioural control and behavioural intention), and on physical activity behaviour. The longitudinal MIMIC models across three behavioural domains (leisure-time, workplace and total physical activity) included intervention group as predictor of the outcome variables (TPB latent factors and behaviour). The paths from attitudes, subjective norms, PBC and behaviour at baseline and Time 1 were all significant, indicating auto-regressive effects for TPB and behavioural latent factors. This was indicated by the significant paths from TPB latent factors at baseline to TPB latent factors at Time 1, and from past physical activity behaviour to prospective behaviour and prospective TPB latent factors. These results suggested that employees used the information about cognitions at baseline and past behaviour to determine their prospective cognitions.

Regarding the intervention effects, the MIMIC models showed that the intervention had small, significant effects exclusively on participants' attitudes after the intervention across all domains, but had no significant effects on behaviour, except for workplace physical activity behaviour (WPA) immediately after the intervention (Time 1). This result was also found in the models after controlling for past behaviour and background factors. However, no significant differences were found in the workplace physical activity behaviour at Time 2, indicating that the effect was short lived. These data were also supported by independent sample t-tests, which did not show relevant significant differences in TPB items and physical activity variables except for attitudes at Time 1.

The intervention, however did not produce long-term and sustained behaviour change and the effects were also small. This is consistent with findings reported in some TPB-based literature reviews (Hardeman et al., 2002; Rhodes & Pfaeffli, 2010) and in technology-based interventions literature (Webb et al., 2010), and with workplace physical activity promotion using periodic prompts (Dugdill et al., 2008; Fry & Neff, 2009). Small or limited intervention effects were also reported in some TPB studies (e.g., Hardeman et al., 2011; Plotnikoff et al., 2007).

The lack of intervention effects in the domains of total and leisure-time physical activity might be explained by the fact that the small intervention effects were found in the attitude latent factor, which was not a significant predictor of behaviour. Therefore, any improvements in that factor were not translated into behaviour change.

Another possible interpretation for the small and limited effects of the intervention on behaviour might be attributable to a "ceiling effect" noticed in physical activity measures. The levels of physical activity for the majority of the sample were already very high at baseline and perhaps participants did not need additional prompts to do more activities. Therefore no exceptional changes in physical activity behaviour could have been expected. The issue of ceiling effect related to the measurement of behaviour is further discussed in the limitations.

5.3.1 Effectiveness of e-mail versus text messages

Significant intervention effects (as indicated by significant path coefficients from the intervention variable to the latent factor) were found in the intervention group receiving only e-mails, which scored significantly higher than the other group in attitude scores and in workplace physical activity. In line with Plotnikoff et al.'s 2005 study and with other studies implementing e-mails for physical activity behaviour promotion (e.g., Block et al., 2008; Dunton & Robertson, 2008; Franklin, Rosenbaum, et al., 2006; van Wier et al., 2011), e-mails seemed to produce better improvements in cognitions (attitudes) and behaviour (but only for workplace physical activity) than text messages.

Contrary to the expectations and to the research hypothesis related to objective two, text messages as reminders reinforcing e-mail communication did not produce significant changes in behaviour or in TPB factors. In other terms, text messages were not associated with better behavioural outcomes or significant improvements in TPB socio-cognitive factors predicting physical activity behaviour. However, these findings are consistent with those described in recent reviews on the use of periodic prompts (Dugdill et al., 2008; Fry & Neff, 2009) and text messages for health behaviour change and disease management (Cole-Lewis & Kershaw, 2010; Krishna et al., 2009). In particular, the reviews about text messages found that these media produced small to null effects in interventions promoting behaviour change, but were effective in disease management and treatment, for example for diabetes or other chronic conditions (Cole-Lewis & Kershaw, 2010; Krishna et al., 2009). This might indicate that text messages and SMS reminders might work better when people have to engage in a "mandatory behaviour", such as taking pills or getting a medication, which are important or fundamental for the treatment of a disease or management of a chronic condition. In other terms, these technologies might be less effective in influencing a behaviour such as physical activity, which largely depends on volitional control, but is not perceived as life-threatening as not complying to a medical treatment.

5.3.2 Background factors and TPB

According to the TPB, background factors, such as gender, ethnicity, education, etc., are considered distal determinants of intention and behaviour as the TPB core constructs mediate the relationships with these two outcome variables (Ajzen, 2011; Ajzen & Fishbein, 2010). In this study, the relationships between background factors, TPB observed variables and physical activity behaviour were inspected using t-tests, ANOVA tests and correlations; only small associations were found among background factors, including gender, age, education, perceived health status, work status, and family status. No large effects and significant differences among participants were found. The trends in physical activity and TPB variables were similar across the sample. Background factors were included in the SEM models when they were found significantly associated with TPB or physical activity variables. For instance, longitudinal MIMIC models were corrected for including background factors that were significantly related with TPB variables at baseline and Time 1, and with physical activity at baseline, Time 1 and Time 2 (see Tables 7.14 to 7.19 in Annex A). The only background factor that was strongly correlated with TPB items measured at baseline was perceived health status. Perceived health status was found an important predictor of some TPB items and physical activity behaviour: in this study, employees who perceived their health status as good tended to score higher in physical activity and TPB scales. These findings are consistent with Kaewthummanukul and Brown's review (2006) and might be explained by the fact that the sample of participants included people who were mostly in good health and that engaged in high levels of physical activity already. In line with the TPB literature, the socio-cognitive determinants were found to mediate the relationship between behaviour and background factors.

Even though correlations with background factors and TPB items were not large in size, this might not exclude potential moderation effects of background variables. Some TPB studies reported also significant effects of age, gender or ethnicity used as moderators of the relationships outlined in the TPB model (Blanchard et al., 2007; Plotnikoff et al., 2004). In this study, considering the research objectives and research questions, moderation effects related to different background characteristics were not investigated, except for tests for measurement invariance involving the intervention group (see paragraph 4.4.4).

5.4 Objective three: reasons for participation

The third objective of the present study was to examine eligible employee's reasons for participating and not participating in the MoveM8 programme, in order to provide a deeper understanding of what motivates employees to sign up for a workplace physical activity promotion intervention. These results can be helpful for the development of future studies and interventions, by knowing what drives potential participants' motivations and what convinces them to subscribe in a workplace health promotion programme. Perhaps most importantly, this study brings an important contribution to the understanding of factors influencing non-participation.

5.4.1 Individual's personal sphere factors

Consistent with the research hypothesis, participation in the programme was influenced by a combination of factors, related to the individual's personal sphere or innermost needs (i.e., weight management, need to be active, curiosity), to the programme characteristics, and to "external" factors, which pertain to an extra-personal perspective (i.e., being recommended or participating for collegiate spirit).

Among the reasons for participation related to the individuals' sphere, the most important themes were linked to the need to be active, to the need and desire to lose weight and to the curiosity about the intervention. Weight management was one of the strongest themes that emerged in both focus groups and individual interviews, suggesting that people who participate in these studies are attentive to better managing their weight (not necessarily only losing it). This result is consistent with findings reported in the literature about participation in workplace health promotion (Kaewthummanukul & Brown, 2006; Robroek et al., 2009) and in some studies targeting weight loss (McHugh & Suggs, 2011; Neve et al., 2010). Weight management clearly emerged as strong theme in the focus groups, which were mainly composed of female participants, and also in individual interviews among female participants. These results might suggest that female employees might be more attentive to elements related to weight management and health and is consistent with the fact that female employees tend to participate in health promotion programmes more than male employees (e.g., Berry et al., 2010; Kaewthummanukul & Brown, 2006; Robroek et al., 2009). Therefore, weight management might be one of the reasons why female employees enrol in workplace health promotion programmes targeting physical activity.

Noteworthy findings about personal characteristics associated with non-participation in the MoveM8 came from the interviews with non-participants. The most salient theme emerged was “living a busy life”, which translates into not having enough time to get involved or to complete surveys, etc. Time management is a challenging aspect for many people and has been reported as factor influencing participation in physical activity studies (e.g., Chinn et al., 2006), and a barrier to participation in physical activity among employees (Kaewthummanukul & Brown, 2006), especially for women with children (Tavares & Plotnikoff, 2008). Time management emerged as a critical aspect for participation in the interviews with employees who did not participate in the MoveM8 programme.

5.4.2 Programme characteristics

Among the reasons related to programme characteristics, reminders emerged as an important attractive element for employees. In fact, many employees explicitly recognised that they enrolled in the programme because they expected to be reminded (by e-mail or SMS) to do some more activities. This is consistent with the role of periodic prompts for behaviour change as reported in the literature (e.g., Fry & Neff, 2009). Since the MoveM8 intervention showed small significant effects on attitudes and workplace physical activity behaviour associated with the use of e-mails, it might be advisable to prefer using e-mails as reminders or cues to action, instead of text messages.

However, the results of the interviews suggest that "reminders" in general were a reason for employees to enrol in the MoveM8 programme. In fact, among the reasons for non-participation in the programme, participants revealed that they had negative relationship with technology (in particular with mobile phones), and this aspect prevented them from completing the enrolment in the MoveM8. Therefore, the fact that text messages were not as effective as e-mails in influencing behaviour, does not mean that text messages cannot be used effectively as reminders to promote a behaviour such as physical activity. It may be that personal preference towards technology or the fact of being reminded could influence programme outcomes rather than the medium itself. Thorough investigations should be made on end users' technology preferences and habits before investing resources on interventions that might not be effective, primarily because employees are not familiar with these technologies. A possible solution might be to let the users decide which "medium of communication" use, so that more relevant content could be delivered to them.

Lastly, the theme related to the "non relevance" was associated with the fact that some employees, who considered themselves as already sufficiently active, did not conclude the enrolment programme because they did not see it as relevant. This was consistent with the findings by Chinn and colleagues' study (Chinn et al., 2006), which indicated that non participants in a physical activity promotion trial considered that they already exercised enough to maintain health. This makes sense, but it is not reflected in the results of the surveys presented in the previous chapter. In fact, the majority of the sample was already highly active at baseline, but enrolled in the study nonetheless. During the interviews, several employees mentioned that that they participated because they were simply interested or curious to see what the programme was about, even though they did not particularly need motivation or suggestions to do more physical activity. Therefore, a more careful planning of the promotion could be granted to identify relevant segments of the population, so that those most in need might be reached.

Another reason associated with the programme characteristics was the perceived ease of use of and ease of access to the programme, or, in other terms, linked to the usability and quality of the programme. These elements have been recognised in the literature and Bennett and Glasgow stressed their importance in the domain of Internet-based public health interventions (Bennett & Glasgow, 2009). Future interventions targeting employees might carefully consider providing usable and user-friendly services.

5.4.3 External factors

According to the research hypothesis and in line with workplace health promotion literature findings, organisational or "environmental" factors (e.g., organisation characteristics, employer support, organisational "culture of health") should also have appeared as elements influencing participation. However, these did not explicitly emerge as salient themes except for the theme "being recommended", which might be linked to an environmental factor pertaining to the role of the organisation or of the employer in promoting the MoveM8 intervention. A possible reason why no other environmental factors were explicitly mentioned in the interviews is that most participants belonged to academic institutions that already provide employees with various health promotion schemes, have fitness facilities on campus, and have established a "culture of health" for a long time (Musich et al., 2009; Pronk & Allen, 2009). So these elements could have been implicitly considered as "normal" or "implicit" for most interviewees.

Being recommended emerged as a theme among the reasons for participation in the MoveM8 programme. In fact, according to some interviewees, they signed up because they received an endorsement from someone in the organisation they worked for, such as colleagues, bosses, or occupational health advisors. This element also emerged from the interviews with those employees who did not participate in the MoveM8. The boss initially endorsed the enrolment and some employees decided to sign up, but then the employer did not follow-up and did not provide enough information to them. The lack of employer support might be connected to the low participation rates reached by the MoveM8 programme itself, but this aspect will be further developed in the limitations.

These results confirm the evidence of the important role the employer has in promoting and endorsing workplace health promotion programmes, as reported in some literature (DeJoy et al., 2009; Heinen & Darling, 2009; Pelletier, 2005). Various authors argued that the role of managerial support and long-term commitment is fundamental to the success of workplace health promotion programmes in general (Fielding, 1984; Harden et al., 1999; Marshall, 2004) and was also associated with effectiveness in work-related outcomes (e.g., Aldana, 2001; Chapman, 2005b; Kuoppala et al., 2008). In fact, "endorsement by a credible and/or respected person in a social network within the organization would result in a relatively high enrolment within the intended population. In this setting, individuals may volunteer out of a desire to please the respected individual, to receive social approval, and/or because valued others (e.g. friends) enrol, rather than because of a true desire to participate in the programme " (Thompson et al., 2006, p. 435). On the other hand, one of the factors that negatively influenced participation in the MoveM8 was weak employer support (linked to the lack of follow-up of the initial contact).

Another element to support the important role plaid by the organisation in promoting health among employees is that occupational health advisors helped advertising and organising the focus groups in two of the organisations that participated in the programme. Without their support and efforts, these focus groups could not be conducted.

Most notably, no external factors explicitly emerged as themes in the focus groups. This might be explained by the fact that some of the participant employees who were in charge of promoting the MoveM8 programme within their worksite were actively participating in the interviews. These employees were also participants in the MoveM8 programme. From the field notes collected during the interviews emerged some evidence of established power relationships between the so called 'workplace health advocates' and other employees. Workplace health advocates are usually considered responsible for any health initiative conducted at their workplace, and they could have been considered responsible also for the MoveM8, as they were proactively involved in its promotion. This fact would have become an implicit "external reason" for the participants to sign up to the programme. However, the presence of these established power relationships, mixed with a potential fear to lose face in front of the others, might have influenced participants' responses, who provided overall very positive feedback and did not mention any negative aspect associated with the role played by their workplace health advocates.

5.5 Limitations

There are several limitations that must be considered when interpreting the results of this study. These include general aspects of technology-based studies and some methodological aspects, such as recruitment, participation and response rates, assessments, and limitations of the analyses involved.

5.5.1 General limitations of the research

The results of this study, both quantitative and qualitative, should be interpreted in light of some general aspects of technology-based interventions. A first matter of concern might be fact that participation was based on the requirement that employees utilised e-mail and mobile phones. This fact *per se* might have excluded less tech-savvy employees or those who were not familiar with these technologies. Interviews with non-participants highlighted that some employees did not enrol because of a "negative relationship with technology". This is a limitation of this study, but it is a crucial aspect of e-health interventions in general, which by definition imply the use of technologies for communication about health promotion and education. It is clear that these studies might target the "innovators" or "early adopters", but it is also clear that innovations take time to diffuse among the majority of the population, in terms of Diffusion of Innovation theory (Oldenburg & Glanz, 2008; Rogers, 2003). Therefore, those who are less inclined to use new technologies today (i.e., "laggards") might become active users in the future. Developing technology-based interventions and understanding what motivates people to participate is important, so that appropriate strategies could be implemented to speed up the diffusion of these technologies among the masses.

Another limitation of studies involving behaviour change interventions is that these tend to attract people who are very interested or who already contemplate to change, in terms of the Transtheoretical Model (Prochaska, Redding, & Evers, 2008). Various studies reported the tendency for highly motivated and healthy employees to participate in workplace health promotion programmes (e.g., Bull, Gillette, Glasgow, & Estabrooks, 2003) and in physical activity interventions involving the use of technologies (Marcus et al., 1998). This study tried to address this aspect by examining the reasons for non-participation in it through interviews with those employees who did not complete enrolment in the study. However, non-enrolled employees were recruited from a population that *de facto* already demonstrated some interest towards the programme, as they started the enrolment process. It is not yet known what factors would motivate non interested employees to enrol.

This study might have attracted employees already contemplating to increase their physical activity, but it also attracted many who were already highly active. The fact that employees who enrolled in the programme were already active on the onset brings forth the long-discussed issue of "preaching to the converted", which has been recognised in the literature (Glasgow et al., 1993; Goetzel & Ozminkowski, 2008; Harden et al., 1999; Zavela, Davis, Cottrell, & Smith, 1988) and might be an intrinsic problem of primary prevention approach, which targets an healthy minority to gain future health benefits for the whole society. This issue leaves open the question about how to promote health promotion programmes to those who would need these programmes the most. Future studies should examine why people do not enrol in these programmes in the first place. The problem, however, is not easy to solve, as this population is hard to reach: they would not explicitly manifest interest, or they would not voluntarily accept to enrol in a study. A possible strategy for investigating this aspect in the workplace could involve "internal sources" of information, such as occupational health advisers or workplace health advocates, who might informally observe and record the views of those who remain silent or do not participate in these programmes, as they seem to be afraid to participate in academic research.

5.5.2 Recruitment strategy

Another limitation of this study was recruitment of participating organisations and employees, which is reflected in low participation rates (discussed below). Recruitment is challenging in e-health interventions, especially in workplaces (Atkinson & Gold, 2002; Linnan et al., 2002; Marshall, 2004; Serxner et al., 2004; Thompson et al., 2006). The two-step promotional strategy for recruiting organisations was based on word-of-mouth, cold calls and personal contacts with potentially interested organisations. It has to be highlighted that no organisations contacted by cold-calls enrolled in the study; personal contacts with employers or occupational health advocates were the most successful recruitment strategy. Consequently, only when established relationships with targeted organisations were in place, employers and occupational health advisors positively responded to the promotion and decided to enrol in the study. Future studies should try to maximise recruitment of organisations by trying to build, establish and maintain relationships with potential stakeholders within the organisations, so that they will be more inclined to support such interventions. Building relationships with potential partners demands time, resources and careful planning. A possible strategy for achieving this might be to involve the organisation in the planning and in the design of the health promotion project from the beginning. An active collaboration and engagement with the organisation might also help identifying strategic influential and stakeholder that could help recruiting employees in a second step.

This study attracted employees from various types of organisations, including some small and medium enterprises, but most participants came from large academic institutions or large companies (according to the estimated employee population). The sample of employees coming from SMEs appeared under-represented, but this issue is in line with findings reported in workplace health promotion literature. As mentioned in the background chapter, workplace health promotion programmes are more often carried out in large organisations in both private and public sectors (Fielding, 1984; Linnan et al., 2008; Pelletier, 2005, 2009), whereas SMEs remain a hard to reach target, mainly because managers and employers find difficult to support these programmes for lack of time and resources (Dugdill et al., 2008). Nonetheless, the largest proportion of participants for this study was found in large academic institutions, such as the University of Nottingham, where no specific occupational health adviser is responsible for promoting health among employees. This might be because the total employee population was the largest among the recruited organisations, but also because an apparently more effective promotional strategy was undertaken. As previously mentioned, the success in participation from academic institutions might be attributable to a long lived and well established “culture of health”, which ultimately resulted in a larger proportion of enrolled employees.

Regarding employees participation, the most effective recruitment strategies resulted in a combination of traditional communication channels, involving word-of-mouth among employees and the dissemination of posters and e-mails with the employer’s support and endorsement. Again, employer support was crucial. Those organisations that implemented a widespread and thorough dissemination of posters and promotional materials through occupational health advisers, had larger proportions of participants in the study (both for the intervention and for the interviews/focus groups). However, the use of personal social networks and employer support is not enough to grant that an organisation endorses and supports a health promotion programme and effectively promotes it to the staff.

Better results in terms of promotion would have been achieved if the MoveM8 programme was not just “sold” or given to employees in a top-down way, but if it was rather based on a shared decision making process and if employees were involved in the development of the intervention itself. Involvement of and collaboration with the target population could be obtained by a long-term strategic work with the organisation and with the staff. Active involvement might increase the perceived relevance and commitment of the target population and might also provide useful information and “insight” in social marketing terms (French, Blair-Stevens, McVey, & Merritt, 2009; Kotler & Lee, 2008).

Another characteristic of this study is that it attracted a large proportion of women. This might be explained by the fact that male employees tend to participate in workplace health promotion programmes more than male employees (Kaewthummanukul &

Brown, 2006; Robroek et al., 2009). This might mean that female employees find health promotion programmes more interesting or that are more attentive towards health issues. For instance, one of the strongest themes that emerged from the interviews with participant employees was weight management and it was declined as “need to lose weight” mostly for female employees. Another possible explanation for this might be that males tend to be more active than women (Crespo et al., 1999; Plotnikoff et al., 2004; WHO, 2011c) and perhaps they might not have perceived a physical activity promotion intervention as needed as females did. A possible solution to increase participation among male employees might be tailoring the intervention to them, but research should try first understanding what would motivate them to participate or not to participate. Therefore, more research should be done in this sense, by focusing on male employees so that their point of view could emerge.

5.5.3 Participation rates

Another limitation of this study is the participation rates, which were low across the enrolled organisations. Of the estimated total population of employees across the enrolled organisations (N = 32,500), the average participation rate was 1.25%. This is lower than what it is reported in recent reviews of workplace health promotion programmes (see Robroek et al., 2009: participation ranged from 10% to 64% with a median of 33%), but low participation rates have been reported in health promotion programmes in general (Lewis et al., 1996; Robroek et al., 2009), in technology-based worksite physical activity interventions (e.g., Cook, Billings, Hersch, Back, & Hendrickson, 2007; Spittaels & De Bourdeaudhuij, 2007; Spittaels, De Bourdeaudhuij, Brug, & Vandelanotte, 2007) and in the review literature about technology based programmes (Neville et al., 2009). To increase the chances for recruitment, flexible procedures and extended enrolment periods were implemented, but this was not sufficient for granting higher participation rates.

5.5.4 Attrition and survey response rates

Closely associated with participation rates are attrition rates for longitudinal data, which were reflected in low survey response rates. Attrition rates ranged from 59% at Time 1 to 64% at Time 2 after the intervention. High attrition rates are not uncommon in workplace health promotion programmes and in web-based interventions (Linnan et al., 2002; Postel et al., 2011; Vandelanotte, Duncan, Plotnikoff, & Mummery, 2012), and comparable data were reported in some studies that were targeting employees: for instance, in a study based on a workplace tailored health risk assessment intervention, reported that 95% of participants did not complete the follow-up HRA survey (McHugh & Suggs, 2011). Another study by De Cocker and colleagues (2011) who used e-mail communication to promote physical activity among adolescents, reported an attrition rate of 53% (De Cocker et al., 2011). In a recent study by Vandelanotte and colleagues (2012), the attrition rates in a web-based physical activity intervention reported about 66% of attrition rates in two intervention groups employed in the RCT study design (Vandelanotte et al., 2012). These results are also in line with data reported in systematic reviews about web-based survey response rates, which could range from 10% to 80% (Manfreda, Bosnjak, Berzelak, Haas, & Vehovar, 2008) with an average response rate of 40% (Cook, Heath, & Thompson, 2000).

One of the possible reasons for the low response rates could be related to the length of the surveys, which included a full TPB assessment and IPAQ-L version. Considered the research objectives and the need to accurately assess physical activity and TPB measures did not allow reducing the length of the survey. Strategies to reduce respondent burden were implemented, by providing employees with the possibility to interrupt and resume the surveys and allowing for some flexibility in the data collection. The use of incentives could have helped, but the study had no budget to cover this aspect.

Attrition bias was inspected and investigated statistically and no significant differences were found between respondents and non-respondents. To appropriately account for the high attrition rates in this study, missing data were appropriately dealt with full information maximum likelihood (FIML), which is one of the most frequently adopted modern missing data statistical techniques (Baraldi & Enders, 2010; Kristman et al., 2005; Raykov, 2005; Schafer & Graham, 2002; Twisk & de Vente, 2002). Nevertheless, future studies should try to minimize attrition by providing alternative strategies to data collection, by reducing the respondent burden (e.g., reducing the number of questions), by including an incentive structure or by introducing a missing data planned design.

5.5.5 Methodological limitations

Among methodological limitations, there is the absence of a true control group, which did not receive an intervention, so it is not possible to conclude that the intervention had no effects on the target population. However, the focus of the study was to test the effect of the additional SMS text messages to e-mail communication, which already showed positive results in other studies that used e-mails for promoting physical activity among employees (Franklin, Ploutz-Snyder, et al., 2006; Franklin, Rosenbaum, et al., 2006; Marshall et al., 2003; Plotnikoff et al., 2005; van Wier et al., 2011).

Another limitation consisted of relying only on self-reported measures of behaviour, which might have resulted in a response-bias or in overestimation of the levels of physical activity, as they declined over time, contrary to expectations. This is one of the weaknesses of self-reported measures of physical activity. However, as already mentioned in the background chapter (paragraph 2.1.2), the reliability and validity of the IPAQ-L instrument against objective measures of physical activity has been already demonstrated (Craig et al., 2003; Fogelholm et al., 2006). Furthermore, the potential issue of over-reporting of the IPAQ long format was also reported in the literature (Ekelund et al., 2006b; Hagströmer et al., 2008; Hagströmer, Ainsworth, Oja, & Sjöström, 2010; Heesch, van Uffelen, Hill, & Brown, 2010; Rzewnicki et al., 2003).

Another possible limitation of the study was the time-lag between assessments which did not allow for an accurate correspondence between the TPB intentions to engage in prospective physical activity behaviour and current cognitions. A shorter time-lag between cognitions and behaviour assessment could have granted a better theoretical fidelity and more precise behavioural prediction (Ajzen, 1985; Ajzen & Fishbein, 2010).

The results of the qualitative interviews and focus groups reflected the unique and personal views of those who were interested in and agreed to participate in the interviews, so have to be interpreted with the context and their characteristics in mind. The small number of interviews collected from non-enrolled employees can constitute a limitation of the study, as the views might not be representative of the whole target population. However, qualitative studies often rely on small sample sizes, since their aim is to investigate a phenomenon in depth rather than in breadth and usually follow a positivistic approach which does not imply seeking generalizability or ecological validity (Marshall, 1996; Miles & Huberman, 1994; Patton, 1990). It has to be acknowledged that it was tried to minimise this problem by using a combination of interview techniques (focus groups and individual interviews) and sampling strategies. The fact that results of focus groups and interviews were comparable in their essence might indicate that the emerged themes were represented in the target population of MoveM8 participants. This allowed for elaboration about a comprehensive view of the motivations and reasons for enrolling in a technology-based programme promoting physical activity.

5.6 Conclusions

This dissertation investigated the use of the Theory of Planned Behaviour for predicting physical activity in the workplace, and the effects of a theory-designed and technology-based intervention (MoveM8) on physical activity its socio-cognitive determinants. This study also explored and discussed the reasons for participating in the MoveM8, but, most notably, it provided insight about the reasons for which employees did not participate in it.

This investigation had three aims: the first was to test the predictive utility of the TPB; the second was to test whether the MoveM8 intervention had significant effects on behaviour and on TPB constructs; the third was to identify the factors associated with participation and non-participation in the MoveM8.

5.6.1 Utility of the Theory of Planned Behaviour

The findings associated with the first objective support the utility of the Theory of Planned Behaviour in describing and predicting physical activity among a population of active, predominantly female, and healthy employees, working for a variety of workplace settings across the United Kingdom. In line with other research, the TPB model significantly predicted intention to engage in physical activity and the behaviour in the domain of leisure-time physical activity and total physical activity. The TPB confirmed to be a useful theoretical framework that should be used for understanding the socio-cognitive determinants of physical activity among employees. In particular, this study found that PBC was the strongest predictor of intention and had significant indirect effects on behaviour among employees. This means that employees with positive and strong control over their own actions were more likely to produce favourable intentions to engage in physical activity and translate the intentions into action. Consistent with other research, this suggests that the perception of control over the behaviour (or self-efficacy) plays a crucial role in determining physical activity among working age adults. However, the fact that PBC was the strongest predictor of behaviour does not mean that the other components of the TPB model should be neglected. According to the TPB, intention mediates the relationship between attitudes, subjective norms, PBC, and behaviour. Focusing only on one component might not have an effect on behaviour. Future TPB-based interventions might further explore the role of PBC among employees, by leveraging the associated control beliefs, so that it could be possible to outline better informed strategies to change PBC, and that might translate into positive changes in behaviour.

Furthermore, the results of this investigation confirmed the significant role of past behaviour into the prediction of prospective behaviour. Findings suggest that employees who were highly active at the beginning of the intervention were likely to maintain their behaviour over time and across physical activity domains. This highlights the importance of keeping on promoting and encouraging physical activity behaviour among employees. To obtain sustained and significant changes in physical activity it is recommended to continue promoting physical activity as "normal" behaviour, so that it could become a habit and be maintained over time. In general, if employees find a favourable environment that is expression of the organisations' "culture of health", they will be more likely to engage in the desired health behaviours and maintain them, so that sustained behaviour changes might occur. Future public health interventions should address physical activity by developing and establishing long-term plans and policies that facilitate access to physical activity among old and new employees.

This study brings a unique contribution to the TPB research methodology by evaluating the Theory of Planned Behaviour using structural equation modelling techniques. Other studies have utilised SEM techniques with the TPB model, but not many focused on physical activity only, and few studies combined the application of SEM techniques in the context of various workplaces, as done in this dissertation. In this dissertation SEM techniques were used not only to test the TPB, but also to estimate and evaluate through confirmatory factor analysis the reliability and validity of a TPB measurement instrument, developed according to the recommendations of the literature. This approach allowed the identification of some issues associated with current and established methods used to assess TPB constructs, and provided an efficient application of a TPB-based instrument.

It has to be noted that, in this study, the Theory of Planned Behaviour was used not only to predict and describe the behaviour of the target population, but also to change their behaviour, as it guided the design and the evaluation of a technology-based physical activity communication intervention. In light of new evidence about the effectiveness of theory-based workplace physical activity interventions, future studies promoting physical activity among employees should continue using the TPB as guiding framework to design, develop and evaluate this behaviour.

5.6.2 Intervention effects

The findings related to the second objective partially substantiate the effects of an e-mail and text message intervention in changing behaviour and TPB constructs. In fact, significant intervention effects were associated with changes in attitude at post-test, and changes in physical activity in the workplace domain. In line with other research, these changes were small in size and were not sustained over time, meaning that no significant intervention effects were found after the intervention finished. This might imply that long-term behavioural change interventions should be implemented, in order to maintain behavioural changes.

This study also contributes to the e-health literature by examining the effects of an e-mail based intervention with an addition of text messaging on physical activity behaviour and on its socio-cognitive determinants. Contrary to the hypotheses, more positive outcomes were found in the intervention group who received only e-mails, rather than in the group that received the additional two SMS. The e-mail only group scored significantly higher than the e-mail plus two SMS group on attitudes and workplace physical activity scales after the intervention.

In light of the intervention effects, whilst this study did not confirm that more reminders are associated with larger changes in TPB constructs and behaviour, it did partially confirm the use of e-mail prompts for producing behaviour changes. However, one cannot conclude that SMS reminders should not be used to communicate about important health issues, as they might work better for specific segments of the population. The low costs coupled with the pervasiveness of mobile technology still make the use of text messages appealing and promising. In fact, other research has shown that text messaging and mobile phones can be effectively used for health communication, in particular for disease management and prevention. Additionally, the recent growth of "m-health" highlights that more research is needed to identify the best ways to use these technologies SMS and mobile phones in general, for example by exploiting and taking advantage of the two-way interactive capabilities of this technology. Future research should not only examine different ways of interaction, but also consider the timing, frequency, dosing and modality of use. It is likely that for some audiences, especially the younger ones, using SMS for communicating and interacting is the preferred way of communication. The growing market of smartphone applications might also be an important venue for research as more and more people download health-related applications on their phones.

5.6.3 Reasons for participation

Regarding the third research objective, results from qualitative interviews with employees who participated in the intervention suggested that participation was influenced by a combination of individual, organisational and environmental factors. Among individual factors, the decision to participate in the MoveM8 was positively influenced by the need to better manage weight and to become more active. Among factors associated with the programme, employees explicitly mentioned they wanted to receive reminders that would encourage them to engage in more physical activity. Therefore, mobile phones and e-mails could both act as effective behavioural "prompts" for participants expressively needed them as motivators to engage in more physical activity. Furthermore, participants said that the perceived ease of use of the programme, coupled with recommendations by colleagues were key elements that influenced their decision to enrol. In general, therefore, these results confirm the role of technology-based prompts as cues to action.

On the other hand, interviews with those who did not participate in the intervention revealed that lack of time, lack of confidence with the technology, and lack of employer support were the strongest factors that hindered participation. This suggest that future health promotion programmes in the workplace should try to reduce these barriers by promoting time management tools, highlighting the benefits of physical activity, providing support to those who are not keen on technologies, and investing on gaining employers' support and endorsement so that more employees could participate in these programmes.

A number of caveats need to be noted regarding the present study. The most important limitation lies in the fact that participation in the study was low and that attrition rates were high. Future studies should consider ways to maximise participation and reduce attrition rates. In general, to increase participation in these programmes it is recommended to: a) obtain organisational support by involving key stakeholders within the organisation from the start of the project, so that they could provide support in the development of an intervention more adapted to the organisation and in its promotion; b) thoroughly investigate end users' preferences, choices and beliefs towards technology so that the appropriate means of communication with employees could be chosen; c) identify possible technical, technological, environmental and organisational barriers to participation before planning an intervention; d) develop careful planning for the promotion; e) provide incentives for participating in and completing interventions and assessments.

Furthermore, the MoveM8 programme attracted mostly employees who were already highly active and already interested in increasing or maintaining their physical activity. This is a common issue of other e-health and health promotion programmes, and the results of this study might be used to compare determinants of low active or sedentary population and might be suitable for designing workplace physical activity programmes that are tailored to both active and less active individuals. Future studies should try to appeal to a larger audience within the target population, by involving segments that do not actively demonstrate interest towards health promotion programmes. This will facilitate the more population-based public health advancements.

More work on factors to facilitate participation in such studies and programmes is necessary before the objectives related to government physical activity priorities are realised.

5.6.4 Summary

The Theory of Planned Behaviour is useful to predict physical activity behaviour among employees. Future studies should use this theory to design, assess, evaluate and predict physical activity behaviour and its socio-cognitive determinants.

This study confirmed the important role of technology-based reminders, in particular e-mails, as cues to action for promoting and maintaining physical activity in the workplace. Future interventions should incorporate e-mails, text messages or other types of prompts to motivate participants to engage in more physical activity, as this was associated with significant intervention effects. Long-lasting programmes are needed to see whether these changes could be maintained over time, and more studies should evaluate the differences between e-mails and text messages for long-term behaviour change.

Participation in a technology-based workplace physical activity communication programme was influenced by aspects related to individual's needs and motivations to become more active, characteristics of the programme itself, and with organisational support. To maximise participation, future studies should stress the importance of perceived benefits, involve organisations and employees in the design and creation of programmes, and facilitate access to these programmes by providing tangible incentives and continuous support so that larger segments of the population are reached.

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ANNEX A
ADDITIONAL TABLES

7.1 TPB direct measures

INTENTION	INT1	I want to get at least 30 minutes of moderate physical activity on at least 5 days or 20 minutes of vigorous physical activity on at least 3 days this coming week. *1 = completely disagree / 7 = completely agree*
	INT2	I intend to get at least 30 minutes of moderate physical activity on at least 5 days or 20 minutes of vigorous physical activity on at least 3 days this coming week. *1 = completely disagree / 7 = completely agree*
	INT3	I expect to get at least 30 minutes of moderate physical activity on at least 5 days or 20 minutes of vigorous physical activity on at least 3 days this coming week. *1 = completely disagree / 7 = completely agree*
SUBJECTIVE NORM	SN1	Most people who are important to me think that... *1 = I should not / 7= I should* get at least 30 minutes of moderate physical activity on at least 5 days or 20 minutes of vigorous physical activity on at least 3 days this coming week.
	SN2	It is expected of me that I get at least 30 minutes of moderate physical activity on at least 5 days or 20 minutes of vigorous physical activity on at least 3 days this coming week. *1 = strongly disagree, 7 = strongly agree*
	SN3	I feel under social pressure to get at least 30 minutes of moderate physical activity on at least 5 days or 20 minutes of vigorous physical activity on at least 3 days this coming week. *1 = strongly disagree, 7 = strongly agree*
PBC	PBC1	I am confident that I can get at least 30 minutes of moderate physical activity on at least 5 days or 20 minutes of vigorous physical activity on at least 3 days this coming week. *1 = strongly disagree, 7 = strongly agree*
	PBC2	For me to get at least 30 minutes of moderate physical activity on at least 5 days or 20 minutes of vigorous physical activity on at least 3 days this coming week would be... *very difficult / very easy*
	PBC3_r	The decision to get at least 30 minutes of moderate physical activity on at least 5 days or 20 minutes of vigorous physical activity on at least 3 days this coming week is beyond my control. *1 = strongly disagree, 7 = strongly agree*
ATTITUDE	ATT1	For me, to get at least 30 minutes of moderate physical activity on at least 5 days or 20 minutes of vigorous physical activity on at least 3 days this coming week would be: *unimportant/important*
	ATT2	For me, to get at least 30 minutes of moderate physical activity on at least 5 days or 20 minutes of vigorous physical activity on at least 3 days this coming week would be: *not enjoyable/enjoyable*
	ATT3	For me, to get at least 30 minutes of moderate physical activity on at least 5 days or 20 minutes of vigorous physical activity on at least 3 days this coming week would be: exhausting/energizing

INT = Intention, SN = subjective norm, PBC = perceived behavioural control, ATT = attitude

7.2 Correlations

Table 7.1. Correlations with selected background factors, TPB items and physical activity variables at baseline (n = 368)

Variables	Gender	Group	Age	BMI	WPA (Baseline)	LTPA (Baseline)	TOTPA (Baseline)	Health status	Edu
ATT1 - Baseline	-.04	.02	.06	-.07	.09*	**.31****	**.25****	*.17***	-.06
ATT2 - Baseline	-.05	.02	-.02	*-.17***	.01	**.31****	**.19****	**.21****	-.06
ATT3 - Baseline	-.03	.02	.01	*-.18***	.01	**.27****	.15**	**.24****	-.08
PBC1 - Baseline	-.13**	.03	-.10*	-.05	.09*	**.31****	**.25****	*.17***	.12**
PBC2 - Baseline	-.06	-.04	-.08	-.05	.01	**.25****	.12*	**.20****	.11*
PBC3 - Baseline	-.02	-.02	.03	.08	-.06	.10*	.02	.07	.05
SN1 - Baseline	-.02	.01	.04	*.18***	.09*	.05	.12*	-.06	.08
SN2 - Baseline	-.05	.01	.03	.15**	.07	**.19****	.15**	.00	.07
SN3 - Baseline	-.07	-.02	-.05	.15**	.09*	.01	.02	-.03	.12**
INT1 - Baseline	-.02	.04	-.04	-.03	.05	**.25****	*.17***	.14**	.02
INT2 - Baseline	-.01	.05	.03	.00	.04	**.29****	**.25****	*.17***	.07
INT3 - Baseline	-.06	.06	-.01	.05	.01	**.29****	**.22****	.15**	.07
WPA - Baseline	-.11*	.00	-.06	-.03	-	-	-	-.03	.06
LTPA - Baseline	-.12*	-.01	-.07	-.10*	-	-	-	.12*	-.04
TOTPA - Baseline	.01	.01	.10*	.02	-	-	-	.07	.10*

Notes: LTPA: leisure-time physical activity; WPA: workplace physical activity; TOTPA: total physical activity; PBCn, ATTn, SNn, INTn: TPB indicators of Attitude, Perceived behavioural control, Subjective norm, and behavioural intention respectively); correlations in gender and group columns represent point-biserial correlations; correlations with education (Edu) and perceived health status are Spearman's rho (ρ); the others represent Pearson's. In bold are highlighted the significant correlations with achieved power .95; in italics are highlighted those achieving a power of .80. * p < .05, ** p < .001 (one-tailed).

Table 7.2. Correlations with selected background factors, TPB items and physical activity variables at Time 1 (n = 155) and Time 2 (n = 136)

Variables	Gender	Group	Age	BMI	WPA (Baseline)	LTPA (Baseline)	TOTPA (Baseline)	Health status	Edu
ATT1 - Time 1	-.05	-.09	-.07	-.04	-.06	*.27***	.15*	.05	-.18*
ATT2 - Time 1	-.06	-.19**	-.08	.10	.05	*.24***	.18*	-.03	-.08
ATT3 - Time 1	-.02	-.15*	-.02	-.07	.07	.18*	.14*	.09	-.09
PBC1 - Time 1	.00	-.16*	*-.25***	-.01	-.06	**.30****	.15*	.07	-.10
PBC2 - Time 1	-.02	-.12	-.14*	-.07	-.16*	*.26***	.12	.10	-.04
PBC3 - Time 1	.03	-.01	-.02	-.03	*-.27***	.11	-.02	-.02	.05
SN1 - Time 1	-.02	-.06	.13*	.12	-.04	.10	.08	-.08	-.06
SN2 - Time 1	.00	-.14*	-.08	.00	-.04	.19*	.20**	.02	-.04
SN3 - Time 1	-.05	.05	-.11	-.02	-.03	.16*	.08	.01	.00
INT1 - Time 1	-.01	-.06	-.06	-.07	-.06	.21**	.12	.06	-.06
INT2 - Time 1	-.01	-.16*	-.11	-.05	-.09	**.30****	.19*	.05	-.13
INT3 - Time 1	.02	-.15*	-.17*	-.08	-.06	*.25***	.16*	.03	-.04
WPA - Time 1	.00	-.09	-.06	.04	**.47****	.01	*.27***	.00	.08
LTPA - Time 1	-.15*	.00	-.11	-.08	.06	**.55****	**.36****	.14*	-.02
TOTPA - Time 1	-.15*	-.03	.04	.05	*.24***	**.38****	**.49****	-.05	.15*
ATT1 - Time 2	-.06	-.12	-.05	.07	.00	**.34****	.21**	-.03	.05
ATT2 - Time 2	-.09	-.05	-.09	.07	.05	**.41****	*.26***	-.01	-.01
ATT3 - Time 2	-.08	-.16*	-.07	.03	.03	**.31****	.21**	-.02	.02
PBC1 - Time 2	-.14	-.14	-.11	.00	.03	**.37****	.16*	-.01	.01
PBC2 - Time 2	-.17*	-.11	-.10	.08	.05	*.23***	.09	-.07	.09
PBC3 - Time 2	.00	-.12	-.02	-.03	-.12	.06	-.16*	-.06	.05
SN1 - Time 2	-.09	.01	.00	*.23***	.14	-.02	.13	-.09	.07
SN2 - Time 2	-.04	-.08	-.03	.11	.12	.22**	.15*	-.18*	.10
SN3 - Time 2	.05	.01	-.04	-.01	-.06	.07	.01	-.01	-.01
INT1 - Time 2	-.02	-.10	-.05	.07	.09	.21**	.19*	-.13	-.07
INT2 - Time 2	-.10	-.164*	-.09	.04	-.04	**.29****	.13	-.04	-.03
INT3 - Time 2	-.06	-.20**	-.02	.01	-.03	**.34****	*.23***	-.04	.04
WPA - Time 2	*-.25***	-.03	-.06	.04	**.52****	-.03	*.26***	-.02	.05
LTPA - Time 2	*-.23***	-.09	-.15*	-.12	.12	**.57****	**.33****	.11	.01
TOTPA - Time 2	*-.29***	-.01	.02	-.01	**.36****	**.30****	**.49****	.00	.08

Notes: LTPA: leisure-time physical activity; WPA: workplace physical activity; TOTPA: total physical activity; PBCn, ATTn, SNn, INTn: TPB indicators of Attitude, Perceived behavioural control, Subjective norm, and behavioural intention respectively); correlations in gender and group columns represent point-biserial correlations; correlations with education (Edu) and perceived health status are Spearman's rho (ρ); the others represent Pearson's.* p < .05, ** p < .001 (one-tailed).

Table 7.3. Intra-class correlations, design effects, F-test and significance values for cluster variables at baseline

	Baseline (n = 368)											
	Cluster (n' =14.4; k = 5)						Workplace (n' = 36.5, k = 17)					
Variables	ICC	des.eff.	F	df1	df2	p	ICC	des.eff.	F	df1	df2	p
ATT1	.00	1.00	1.30	4	177.85	.27	.00	1.00	.99	16	228.43	.46
ATT2	.00	1.03	1.23	4	177.85	.30	.01	1.42	.98	16	228.43	.48
ATT3	.00	1.00	1.84	4	177.85	.12	.02	1.59	1.28	16	228.43	.21
SN1	.03	1.37	1.49	4	177.85	.21	.00	1.00	.66	16	228.43	.83
SN2	.01	1.14	1.28	4	177.85	.28	.00	1.02	1.66	16	228.43	.06
SN3	.00	1.02	1.07	4	177.85	.37	.00	1.00	1.15	16	228.43	.31
PBC1	.00	1.00	.88	4	177.85	.48	.00	1.00	1.42	16	228.43	.13
PBC2	.00	1.01	1.78	4	177.85	.14	.00	1.00	.90	16	228.43	.57
PBC3	.00	1.01	1.16	4	177.85	.33	.00	1.00	1.34	16	228.43	.17
INT1	.00	1.00	.55	4	177.85	.70	.00	1.00	.55	16	228.43	.92
INT2	.00	1.00	.41	4	177.85	.80	.00	1.00	.89	16	228.43	.59
INT3	.00	1.00	.08	4	177.85	.99	.00	1.00	.65	16	228.43	.85
LTPA	.00	1.00	.49	4	177.85	.74	.00	1.00	1.80	16	228.43	**.03**
WPA	.02	1.21	1.25	4	177.85	.29	.00	1.10	1.23	16	228.43	.25
TOTPA	.00	1.00	1.11	4	177.85	.35	.00	1.03	.68	16	228.43	.81

Notes: ICC stands for intra-class correlation; des.eff. stands for design effect, which is calculated the following way: Design effect = 1 + (Avg. Cluster size - 1)* ICC (see Muthén, 1999); Average cluster size (n') = $N^2 - \sum_j^i n^2/N(k-1)$ (see Kenny & La Voie, 1985); p is the significance value of the F-test of the ratio between the mean square between (MSB) and mean square within (MSW, with df1 = k-1, df2 = k(n' - 1), as reported in Kenny & La Voie (1985). Significant values (p < .05) are highlighted in bold.

Table 4.1.2.7. Intra-class correlations, design effects, F-test and significance values for cluster variables at Time 1 follow-up

	Time 1 (n = 155)											
	Cluster (n' = 10.3; k = 5)						Workplace (n' = 14.2; k = 10)					
Variables	ICC	des.eff.	F	df1	df2	p	ICC	des.eff.	F	df1	df2	p
ATT1	.00	1.00	.99	4	66.18	.42	.11	2.51	2.16	9	93.43	**.03**
ATT2	.00	1.00	.98	4	66.18	.43	.02	1.23	1.06	9	93.43	.40
ATT3	.02	1.21	1.28	4	66.18	.29	.04	1.50	1.02	9	93.43	.43
SN1	.00	1.00	.66	4	66.18	.62	.07	1.86	1.70	9	93.43	.10
SN2	.00	1.00	1.66	4	66.18	.17	.03	1.40	1.70	9	93.43	.10
SN3	.00	1.00	1.15	4	66.18	.34	.01	1.13	1.11	9	93.43	.37
PBC1	.00	1.00	1.42	4	66.18	.24	.01	1.15	1.42	9	93.43	.19
PBC2	.00	1.00	.90	4	66.18	.47	.00	1.00	1.06	9	93.43	.40
PBC3	.07	1.67	1.34	4	66.18	.26	.08	2.07	1.97	9	93.43	**.05**
INT1	.00	1.00	1.02	4	66.18	.41	.00	1.00	1.15	9	93.43	.33
INT2	.00	1.00	.63	4	66.18	.64	.08	2.12	2.10	9	93.43	**.04**
INT3	.00	1.00	1.03	4	66.18	.40	.04	1.48	1.62	9	93.43	.12
LTPA	.05	1.48	1.80	4	66.18	.14	.18	3.44	2.31	9	93.43	**.02**
WPA	.00	1.00	1.23	4	66.18	.31	.00	1.00	1.15	9	93.43	.33
TOTPA	.06	1.60	.68	4	66.18	.61	.17	3.23	2.56	9	93.43	**.01**

Notes: ICC stands for intra-class correlation; des.eff. stands for design effect, which is calculated the following way: Design effect = 1 + (Avg. Cluster size - 1)* ICC (see Muthén, 1999); Average cluster size (n') = $N^2 - \sum_j^i n^2 / N(k-1)$ (see Kenny & La Voie, 1985); p is the significance value of the F-test of the ratio between the mean square between (MSB) and mean square within (MSW, with df1 = k-1, df2 = k(n' - 1), as reported in Kenny & La Voie (1985). Significant values (p < .05) are highlighted in bold.

Table 7.4. Intra-class correlations, design effects, F-test and significance values for cluster variables at Time 2 follow-up

	Time 2 (n = 136)											
	Cluster (n' = 9.3; k = 5)						Workplace (n' = 10.6; k = 9)					
Variables	ICC	des.eff.	F	df1	df2	p	ICC	des.eff.	F	df1	df2	p
ATT1	.00	1.04	.50	4	47.89	.74	.00	1.00	.38	8	75.01	.93
ATT2	.02	1.13	.52	4	47.89	.72	.01	1.11	.49	8	75.01	.86
ATT3	.00	1.00	.88	4	47.89	.48	.01	1.05	.81	8	75.01	.60
SN1	.00	1.02	.60	4	47.89	.67	.00	1.01	.89	8	75.01	.53
SN2	.07	1.62	1.53	4	47.89	.21	.04	1.43	1.60	8	75.01	.14
SN3	.00	1.00	1.32	4	47.89	.28	.01	1.06	1.58	8	75.01	.15
PBC1	.02	1.13	.80	4	47.89	.89	.02	1.20	.87	8	75.01	.55
PBC2	.00	1.00	.68	4	47.89	.61	.03	1.24	1.01	8	75.01	.43
PBC3	.00	1.00	1.13	4	47.89	.35	.00	1.00	.97	8	75.01	.46
INT1	.05	1.43	1.11	4	47.89	.37	.02	1.17	.72	8	75.01	.68
INT2	.03	1.24	1.20	4	47.89	.33	.03	1.31	.86	8	75.01	.55
INT3	.00	1.00	1.22	4	47.89	.31	.01	1.09	.81	8	75.01	.59
LTPA	.00	1.00	.39	4	47.89	.81	.00	1.00	.77	8	75.01	.63
WPA	.15	2.27	2.87	4	47.89	**.03**	.04	1.41	1.78	8	75.01	.10
TOTPA	.17	2.42	2.88	4	47.89	**.03**	.20	2.93	2.74	8	75.01	**.01**

Notes: ICC stands for intra-class correlation; des.eff. stands for design effect, which is calculated the following way: Design effect = 1 + (Avg. Cluster size - 1)* ICC (see Muthén, 1999); Average cluster size (n') = $N^2 - \sum_j^i n^2/N(k-1)$ (see Kenny & La Voie, 1985); p is the significance value of the F-test of the ratio between the mean square between (MSB) and mean square within (MSW, with df1 = k-1, df2 = k(n' - 1), as reported in Kenny & La Voie (1985). Significant values (p < .05) are highlighted in bold.

7.3 Power calculations

Table 7.5. Achieved power for Linear multiple regression: Fixed model, R^2 deviation from zero

		Predictors	α	N	ρ^2	f^2	NCP λ	Critical F	df1	df2	1 - β
Scenario 1	1a	1	.05	368	.05	.05	18.72	3.87	1	366	.99
	1b	1	.05	155	.05	.05	7.88	3.90	1	153	.80
	1c	1	.05	136	.05	.05	6.92	3.91	1	134	.74
Scenario 2	2a	3	.05	368	.20	.25	92.00	2.63	3	364	1.00
	2b	3	.05	155	.20	.25	38.75	2.66	3	151	1.00
	2c	3	.05	136	.20	.25	34.00	2.67	3	132	1.00
Scenario 3	2a	6	.05	368	.20	.25	92.00	2.12	6	361	1.00
	2b	6	.05	155	.20	.25	38.75	2.16	6	148	1.00
	2c	6	.05	136	.20	.25	34.00	2.17	6	129	1.00
Scenario 4	4a	1	.05	361	.05	.05	18.36	3.87	1	359	.99
	4b	1	.05	148	.05	.05	7.53	3.91	1	146	.78
	4c	1	.05	129	.05	.05	6.56	3.92	1	127	.72
	4d	1	.05	95	.05	.05	4.83	3.94	1	93	.59
Scenario 5	5a	3	.05	361	.20	.25	61.32	3.87	1	359	1.00
	5b	3	.05	148	.20	.25	25.14	3.91	1	146	1.00
	5c	3	.05	129	.20	.25	21.91	3.92	1	127	1.00
	5d	3	.05	95	.20	.25	16.14	3.94	1	93	.98
Scenario 6	6a	6	.05	361	.20	.25	147.74	3.87	1	359	1.00
	6b	6	.05	148	.20	.25	6.57	3.91	1	146	1.00
	6c	6	.05	129	.20	.25	52.79	3.92	1	127	1.00
	6d	6	.05	95	.20	.25	38.88	3.94	1	93	1.00
Scenario 7	7a	9	.05	361	.20	.25	9.25	1.91	9	351	1.00
	7b	9	.05	148	.20	.25	37.00	1.95	9	138	1.00
	7c	9	.05	129	.20	.25	32.25	1.96	9	119	.99
	7d	9	.05	95	.20	.25	23.75	1.99	9	85	.93

Notes: α is the significance level ($p = .05$); N is the sample size; ρ^2 is the squared population multiple correlation; f^2 is the effect size; NCP is the non-centrality parameter for the Critical F distribution. $1 - \beta$ is the achieved power. Not indicated assumption: minimum explained variance in the dependent variable: 5%.

Table 7.6. Estimated critical t and effect sizes for point-biserial model

	α	1 - β	N	NCP δ	Critical t	df	|ρ|	d	r^2
Scenario 1a	.05	.95	368	3.614	1.966	366	.19	.47	.03
	.05	.95	368	3.614	1.966	366	.19	.38	.03
Scenario 1b	.05	.95	368	3.296	1.649	366	.17	.43	.03
	.05	.95	368	3.296	1.649	366	.17	.34	.03
Scenario 1c	.05	.80	368	2.809	1.966	366	.14	.37	.02
	.05	.80	368	2.809	1.966	366	.14	.29	.02
Scenario 1d	.05	.80	368	2.491	1.649	366	.13	.33	.02
	.05	.80	368	2.491	1.649	366	.13	.26	.02
Scenario 2a	.05	.95	155	3.628	1.976	153	.28	.77	.08
	.05	.95	155	3.628	1.976	153	.28	.58	.08
Scenario 2b	.05	.95	155	3.304	1.655	153	.26	.70	.07
	.05	.95	155	3.304	1.655	153	.26	.53	.07
Scenario 2c	.05	.80	155	2.819	1.976	153	.22	.60	.05
	.05	.80	155	2.819	1.976	153	.22	.45	.05
Scenario 2d	.05	.80	155	2.498	1.655	153	.20	.53	.04
	.05	.80	155	2.498	1.655	153	.20	.40	.04
Scenario 3a	.05	.95	136	3.631	1.978	134	.30	.76	.09
	.05	.95	136	3.631	1.978	134	.30	.62	.09
Scenario 3b	.05	.95	136	3.306	1.656	134	.27	.69	.08
	.05	.95	136	3.306	1.656	134	.27	.57	.08
Scenario 3c	.05	.80	136	2.822	1.978	134	.24	.59	.06
	.05	.80	136	2.822	1.978	134	.24	.48	.06
Scenario 4d	.05	.80	136	2.499	1.656	134	.21	.52	.04
	.05	.80	136	2.499	1.656	134	.21	.43	.04

Notes: α is the significance level ($p = .05$); 1 – β is the required power; N is the sample size; NCP is the non-centrality parameter for the Critical t distribution; |ρ| is the effect size; d is Cohen's d; r^2 is the coefficient of determination.

Table 7.7. Estimated effect size for bivariate normal correlation

	α	1 - β	N	ρ H0	Tail	Lower/upper critical r	ρ H1
Scenario 1a	.05	.95	368	.00	Two	± .10	.19
	.05	.80	368	.00	Two	± .10	.15
Scenario 1b	.05	.95	368	.00	One	.09	.17
	.05	.80	368	.00	One	.09	.13
Scenario 2a	.05	.95	155	.00	Two	± .16	.28
	.05	.80	155	.00	Two	± .16	.22
Scenario 2b	.05	.95	155	.00	One	.13	.26
	.05	.80	155	.00	One	.13	.20
Scenario 3a	.05	.95	136	.00	Two	± .17	.30
	.05	.80	136	.00	Two	± .17	.24
Scenario 3b	.05	.95	136	.00	One	.14	.28
	.05	.80	136	.00	One	.14	.21

Notes: α is the significance level ($p = .05$); $1 - \beta$ is the required power; N is the sample size; NCP is the non-centrality parameter for the Critical t distribution; $\rho\ H_0$ is the correlation of the null hypothesis; r is the critical effect size (Pearson's r coefficient); $\rho\ H_1$ is the correlation coefficient of H_1 model.

Table 7.8. Estimated critical t and effect sizes for independent samples t-test

	α	1 - β	N	n1	n2	Tail	NCP δ	Critical t	df	d	η^2
Scenario 1a	.05	.95	368	73	295	Two	3.614	1.966	366	.47	.01
	.05	.95	368	185	183	Two	3.614	1.966	366	.38	.01
Scenario 1b	.05	.95	368	73	295	One	3.296	1.649	366	.43	.01
	.05	.95	368	185	183	One	3.296	1.649	366	.34	.01
Scenario 1c	.05	.80	368	73	295	Two	2.809	1.966	366	.37	.01
	.05	.80	368	185	183	Two	2.809	1.966	366	.29	.01
Scenario 1d	.05	.80	368	73	295	One	2.491	1.649	366	.33	.01
	.05	.80	368	185	183	One	2.491	1.649	366	.26	.01
Scenario 2a	.05	.95	155	27	128	Two	3.628	1.976	153	.77	.02
	.05	.95	155	72	83	Two	3.628	1.976	153	.58	.02
Scenario 2b	.05	.95	155	27	128	One	3.304	1.655	153	.70	.02
	.05	.95	155	72	83	One	3.304	1.655	153	.53	.02
Scenario 2c	.05	.80	155	27	128	Two	2.819	1.976	153	.60	.02
	.05	.80	155	72	83	Two	2.819	1.976	153	.45	.02
Scenario 2d	.05	.80	155	27	128	One	2.498	1.655	153	.53	.02
	.05	.80	155	72	83	One	2.498	1.655	153	.40	.02
Scenario 3a	.05	.95	136	29	107	Two	3.631	1.978	134	.76	.03
	.05	.95	136	68	68	Two	3.631	1.978	134	.62	.03
Scenario 3b	.05	.95	136	29	107	One	3.306	1.656	134	.69	.02
	.05	.95	136	68	68	One	3.306	1.656	134	.57	.02
Scenario 3c	.05	.80	136	29	107	Two	2.822	1.978	134	.59	.03
	.05	.80	136	68	68	Two	2.822	1.978	134	.48	.03
Scenario 4d	.05	.80	136	29	107	One	2.499	1.656	134	.52	.02
	.05	.80	136	68	68	One	2.499	1.656	134	.43	.02

Notes: α is the significance level (p = .05); 1 – β is the required power; N is the sample size; n1 and n2 are the sample sizes of different groups (e.g., males vs. females; intervention group 1 vs. intervention group 2); NCP is the non-centrality parameter for the Critical t distribution; df are the degrees of freedom; d is Cohen's d; η^2 is the effect size eta squared.

Table 7.9. Estimated critical F and effect sizes for ANOVA tests: fixed effects (omnibus), one-way

	α	1 - β	N	nr groups	NCP λ	Critical F	df1	df2	f	η^2
Scenario 1a	.05	.95	368	6	2.085	2.239	5	362	.23	.05
	.05	.95	368	5	18.816	2.397	4	363	.22	.05
	.05	.95	368	4	17.355	2.629	3	364	.22	.05
	.05	.95	368	3	15.571	3.020	2	365	.21	.04
Scenario 1b	.05	.80	368	6	13.025	2.239	5	362	.19	.03
	.05	.80	368	5	12.092	2.397	4	363	.18	.03
	.05	.80	368	4	11.020	2.629	3	364	.17	.03
	.05	.80	368	3	9.714	3.020	2	365	.16	.03
Scenario 2a	.05	.95	155	6	2.528	2.275	5	149	.36	.12
	.05	.95	155	5	19.169	2.432	4	150	.35	.11
	.05	.95	155	4	17.622	2.665	3	151	.34	.10
	.05	.95	155	3	15.752	3.056	2	152	.32	.09
Scenario 2b	.05	.80	155	6	13.311	2.275	5	149	.29	.08
	.05	.80	155	5	12.318	2.432	4	150	.28	.07
	.05	.80	155	4	11.189	2.665	3	151	.27	.07
	.05	.80	155	3	9.827	3.056	2	152	.25	.06
Scenario 3a	.05	.95	136	6	2.639	2.284	5	130	.39	.13
	.05	.95	136	5	19.258	2.441	4	131	.38	.12
	.05	.95	136	4	17.688	2.673	3	132	.36	.12
	.05	.95	136	3	15.797	3.064	2	133	.34	.10
Scenario 3b	.05	.80	136	6	13.383	2.284	5	130	.31	.09
	.05	.80	136	5	12.375	2.441	4	131	.30	.08
	.05	.80	136	4	11.231	2.673	3	132	.29	.08
	.05	.80	136	3	9.855	3.064	2	133	.27	.07

Notes: α is the significance level (p = .05); 1 – β is the required power; N is the sample size; n1 and n2 are the sample sizes of different groups (e.g., males vs. females; intervention group 1 vs. intervention group 2); NCP is the non-centrality parameter for the Critical F distribution; df1 are the numerator and df2 are the denominator degrees of freedom; f: Cohen's f effect size; η^2 is the effect size (eta squared).

7.4 TPB models predicting behaviour at Time 2

Table 7.10. Path coefficients for the TPB model predicting LTPA at Time 2 (n = 185)

Path	B	B 95% CI		β
Original TPB model				
Attitude to Intention	.17	-.02	.35	.13
Perceived behavioural control to Intention	.75**	.05	.97	.75
Subjective norm to Intention	.15*	.03	.27	.15
Intention to LTPA(T2)	2.93*	.98	4.88	.26
Total effects on behaviour				
Attitude(T1) on LTPA(T2)	.49	-.17	1.15	.03
PBC(T1) on LTPA(T2)	2.21*	.70	3.72	.20
SN(T1) on LTPA(T2)	.45*	-.01	.90	.04
Alternative model including past behaviour				
Attitude to Intention	.18	-.01	.37	.14
Perceived behavioural control to Intention	.76**	.52	1.00	.77
Subjective norm to Intention	.16*	.04	.28	.16
Intention to LTPA(T2)	-.16	-1.90	1.59	-.01
Past behaviour to TPB(T1)				
LTPA(T1) to Attitude(T1)	.03**	.02	.03	.38
LTPA(T1) to PBC(T1)	.04**	.03	.06	.48
LTPA(T1) to Subjective norm(T1)	.02*	.01	.04	.26
LTPA(T1) to Intention(T1)	-.01	-.01	.01	-.05
LTPA(T1) to LTPA(T2)	.63**	.35	.91	.65
Total effects on behaviour at Time 1				
Attitude(T1) on LTPA(T2)	-.03	-.34	.29	.00
PBC(T1) on LTPA(T2)	-.12	-1.46	1.21	-.01
SN(T1) on LTPA(T2)	-.03	-.30	.25	.00
LTPA(T1) on LTPA(T2)	.63**	.36	.89	.64

Notes: B = unstandardized coefficient, β = standardised coefficient; 95% CI is the 95% confidence interval for the unstandardised coefficient; LTPA stands for leisure-time physical activity; T1 and T2 indicate the time of measurement: T1 = Time 1, T1 = Time 2 (16 weeks after baseline). * $p < .05$, ** $p < .001$.

Table 7.11. Path coefficients for the TPB model predicting WPA at Time 2 (n = 185)

Path	B	B 95% CI		β
Original TPB model				
Attitude to Intention	.17	-.02	.35	.13
Perceived behavioural control to Intention	.75**	.05	.97	.75
Subjective norm to Intention	.15*	.03	.27	.15
Intention to WPA(T2)	.00	-.09	.88	.00
Total effects on behaviour				
Attitude(T1) on WPA(T2)	.00	-.15	.15	.00
PBC(T1) on WPA(T2)	.00	-.67	.66	.00
SN(T1) on WPA(T2)	.00	-.14	.14	.00
Alternative model including past behaviour				
Attitude to Intention	.17	-.02	.36	.13
Perceived behavioural control to Intention	.75**	.54	.97	.75
Subjective norm to Intention	.16*	.04	.28	.15
Intention to WPA(T2)	.04	-.68	.75	.01
Past behaviour to TPB(T1)				
WPA(T1) to Attitude(T1)	.01	-.01	.03	.07
WPA(T1) to PBC(T1)	.02	-.01	.04	.10
WPA(T1) to Subjective norm(T1)	.02	.00	.05	.14
WPA(T1) to Intention(T1)	.00	-.02	.01	-.02
WPA(T1) to WPA(T2)	.67**	.51	.82	.79
Total effects on behaviour at Time 1				
Attitude(T1) on WPA(T2)	.01	-.11	.12	.00
PBC(T1) on WPA(T2)	.03	-.51	.56	.01
SN(T1) on WPA(T2)	.01	-.11	.12	.00
WPA(T1) on WPA(T2)	.67**	.51	.82	.79

Notes: B = unstandardized coefficient, β = standardised coefficient; 95% CI is the 95% confidence interval for the unstandardised coefficient; WPA stands for workplace physical activity; T1 and T2 indicate the time of measurement: T1 = Time 1, T1 = Time 2 (16 weeks after baseline). * $p < .05$, ** $p < .001$.

Table 7.12. Path coefficients for the TPB model predicting TOTPA at Time 2 (n = 185)

Path	B	B 95% CI		β
Original TPB model				
Attitude to Intention	.17	-.02	.36	.13
Perceived behavioural control to Intention	.76**	.54	.97	.76
Subjective norm to Intention	.15*	.03	.27	.15
Intention to TOTPA(T2)	6.20**	2.56	9.83	.33
Total effects on behaviour				
Attitude(T1) on TOTPA(T2)	1.04	-.26	2.34	.04
PBC(T1) on TOTPA(T2)	4.68*	1.71	7.64	.25
SN(T1) on TOTPA(T2)	.95*	.04	1.86	.05
Alternative model including past behaviour				
Attitude to Intention	.17	-.01	.36	.13
Perceived behavioural control to Intention	.76**	.53	.98	.76
Subjective norm to Intention	.16*	.04	.28	.16
Intention to TOTPA(T2)	-.18	-3.11	2.76	-.01
Past behaviour to TPB(T1)				
TOTPA(T1) to Attitude(T1)	.01**	.01	.02	.35
TOTPA(T1) to PBC(T1)	.02**	.01	.03	.43
TOTPA(T1) to Subjective norm(T1)	.01**	.01	.02	.32
TOTPA(T1) to Intention(T1)	.00	-.01	.00	-.02
TOTPA(T1) to TOTPA(T2)	-.18	.53	.88	.81
Total effects on behaviour at Time 1				
Attitude(T1) on TOTPA(T2)	-.03	-.53	.47	.00
PBC(T1) on TOTPA(T2)	-.13	-2.35	2.09	-.01
SN(T1) on TOTPA(T2)	-.03	-.49	.44	.00
TOTPA(T1) on TOTPA(T2)	.70**	.54	.86	.806

Notes: B = unstandardized coefficient, β = standardised coefficient; 95% CI is the 95% confidence interval for the unstandardised coefficient; TOTPA stands for total physical activity; T1 and T2 indicate the time of measurement: T1 = Time 1, T1 = Time 2 (16 weeks after baseline). * p < .05, ** p < .001.

Table 7.13. Standardised disturbance terms for all TPB models predicting behaviour at Time 2

Endogenous variable	LTPA	WPA	TOTPA
Original TPB model			
Intention(T1)	.15	.15	.15
Behaviour(T2)	.93	1.00	1.00
Alternative model including past behaviour			
Attitude(T1)	.86	1.00	.88
PBC(T1)	.77	.99	.81
Subjective norm(T1)	.93	.98	.90
Intention(T1)	.15	.15	.15
Behaviour (T2)	.59	.38	.35

Notes: LTPA = leisure-time physical activity; WPA = workplace physical activity, TOTPA = total physical activity; T1 and T2 indicate the time of measurement: T1 = baseline, T2 = Time 1 (16 weeks after baseline). * p < .05, ** p < .001.

7.5 Longitudinal MIMIC models with background factors

Table 7.14. Path coefficients for the longitudinal model (LTPA) with background factors (n = 361)

Path	B	B 95% CI		β
Past behaviour to TPB(T0)				
LTPA(T0) to Attitude(T0)	.03**	.02	.03	.34
LTPA(T0) to PBC(T0)	.03**	.02	.04	.33
LTPA(T0) to Subjective norm(T0)	.02**	.01	.03	.19
LTPA(T0 to Intention(T0)	.00	-.01	.01	.02
TPB and future behaviour (baseline-T1)				
Attitude(T0) to Intention(T0)	.06	-.08	.20	.06
PBC(T0) to Intention(T0)	.69**	.52	.87	.78
Subjective norm(T0) to Intention(T0)	.11*	.03	.19	.14
Intention(T0) to LTPA(T1)	2.50*	.08	4.92	.18
Behaviour at Time 1 to TPB(T1)				
LTPA(T1) to Attitude(T1)	.01*	.00	.02	.18
LTPA(T1) to PBC(T1)	.03**	.01	.04	.34
LTPA(T1) to Subjective norm(T1)	.02*	.00	.03	.20
LTPA(T1) to Intention(T1)	-.01	-.02	.01	-.06
TPB and future behaviour (T1-T2)				
Attitude(T1) to Intention(T1)	.16	-.04	.36	.12
PBC(T1) to Intention(T1)	.75**	.46	1.04	.76
Subjective norm(T1) to Intention(T1)	.15*	.03	.28	.15
Intention(T1) to LTPA(T2)	-.32	-1.75	1.11	-.03
Autoregressive paths				
Attitude(T0) to Attitude(T1)	.57**	.39	.76	.58
PBC(T0) to PBC(T1)	.50**	.29	.72	.46
Subjective norm(T0) to SN(T1)	.40*	.08	.71	.44
Intention(T0) to Intention(T1)	.09	-.07	.26	.08
LTPA(T0) to LTPA(T1)	.55**	.35	.76	.51
LTPA(T1) to LTPA(T2)	.44*	.12	.76	.45
LTPA(T0) to LTPA(T2)	.41**	.15	.67	.38
Background factors				
Health status to Attitude(T0)	.39**	.21	.57	.23
Health status to PBC(T0)	.38**	.17	.60	.19
Health status to LTPA(T0)	3.05*	.66	5.45	.13
Age to PBC(T1)	-.02*	-.03	.00	-.12
Age to Intention(T0)	.01*	.00	.02	.01
Group to ATT(T1)	-.41*	-.78	-.04	-.16

Notes: B = unstandardized coefficient, β = standardised coefficient; 95% CI is the 95% confidence interval for the unstandardised coefficient; LTPA stands for leisure-time physical activity; T1 and T2 indicate the time of measurement: T1 = Time 1, T1 = Time 2 (16 weeks after baseline). * p < .05, ** p < .001.

Table 7.15. Total effects for the longitudinal model (LTPA) with background factors (n = 361)

Effect	B	B 95% CI		b
Attitude(T0) on LTPA(T1)	.15	-.24	.54	.01
PBC(T0) on LTPA(T1)	1.73*	.04	3.43	.14
SN(T0) on LTPA(T1)	.27	-.07	.62	.03
LTPA(T0) on LTPA(T1)	.62**	.41	.82	.57
Attitude(T1) on LTPA(T2)	-.05	-.28	.17	.00
PBC(T1) on LTPA(T2)	-.24	-1.3	.85	-.02
SN(T1) on LTPA(T2)	-.05	-.27	.17	.00
LTPA(T0) on LTPA(T2)	.67**	.46	.88	.63
Group to LTPA(T2)	-2.72	-8.19	2.76	-.07
Age to LTPA(T2)	.00	-.015	.02	.00
Health status to LTPA(T2)	2.26*	.53	.40	.09

Notes: B = unstandardized coefficient, β = standardised coefficient; 95% CI is the 95% confidence interval for the unstandardised coefficient; LTPA stands for leisure-time physical activity; T1 and T2 indicate the time of measurement: T1 = Time 1, T1 = Time 2 (16 weeks after baseline). * p < .05, ** p < .001.

Table 7.16. Path coefficients for the longitudinal model (WPA) with background factors (n = 361)

Path	B	B 95% CI		β
Past behaviour to TPB(T0)				
WPA(T0) to Attitude(T0)	.00	-.01	.02	.01
WPA(T0) to PBC(T0)	.01	-.01	.03	.05
WPA(T0) to Subjective norm(T0)	.01	-.01	.03	.07
WPA(T0 to Intention(T0)	-.01	-.01	.01	-.04
TPB and future behaviour (baseline-T1)				
Attitude(T0) to Intention(T0)	.07	-.06	.21	.07
PBC(T0) to Intention(T0)	.66**	.50	.82	.76
Subjective norm(T0) to Intention(T0)	.12*	.04	.20	.16
Intention(T0) to WPA(T1)	.05	-.89	.99	.01
Behaviour at Time 1 to TPB(T1)				
WPA(T1) to Attitude(T1)	.01	-.02	.03	.05
WPA(T1) to PBC(T1)	.01	-.02	.03	.05
WPA(T1) to Subjective norm(T1)	.01	-.02	.04	.07
WPA(T1) to Intention(T1)	.00	-.01	.02	.01
TPB and future behaviour (T1-T2)				
Attitude(T1) to Intention(T1)	.11	-.09	.32	.08
PBC(T1) to Intention(T1)	.93**	.63	1.22	.95
Subjective norm(T1) to Intention(T1)	.07	-.08	.22	.07
Intention(T1) to WPA(T2)	.05	-.67	.76	.01
Autoregressive paths	-.78**	-1.19	-.37	-.77
Attitude(T0) to Attitude(T1)				
PBC(T0) to PBC(T1)	.62**	.43	.80	.64
Subjective norm(T0) to SN(T1)	.68**	.51	.85	.65
Intention(T0) to Intention(T1)	.57**	.25	.89	.63
WPA(T0) to WPA(T1)	.78**	.38	1.17	.66
WPA(T1) to WPA(T2)	.45**	.28	.62	.49
WPA(T0) to WPA(T2)	.61**	.40	.82	.72
Background factors	.11	-.08	.29	.13
Health status to Attitude(T0)				
Health status to PBC(T0)	-.37*	-.74	-.01	-.15
Health status to WPA(T0)	-2.91*	-5.66	-.16	-.15
Age to PBC(T1)	.47**	.27	.66	.28
Age to Intention(T0)	.45**	.24	.68	.22
Group to ATT(T1)	-.02*	-.03	-.01	-.13

Notes: B = unstandardized coefficient, β = standardised coefficient; 95% CI is the 95% confidence interval for the unstandardised coefficient; WPA stands for workplace physical activity; T1 and T2 indicate the time of measurement: T1 = Time 1, T1 = Time 2 (16 weeks after baseline). * p < .05, ** p < .001.

Table 7.17. Total effects for the longitudinal model (WPA) with background factors (n = 361)

Effect	B	B 95% CI		b
Attitude(T0) on WPA(T1)	.01	-.06	.06	.00
PBC(T0) on WPA(T1)	.03	-.60	.71	.01
SN(T0) on WPA(T1)	.01	-.10	.12	.00
WPA(T0) on WPA(T1)	.44**	.26	.62	.49
Attitude(T1) on WPA(T2)	.01	-.79	.10	.00
PBC(T1) on WPA(T2)	.07	-.43	.56	.01
SN(T1) on WPA(T2)	.01	-.08	.11	.00
WPA(T0) on WPA(T2)	.38**	.21	.53	.48
Group to WPA(T2)	-.02	-.02	.02	-.15
Age to WPA(T2)	.00	.00	.00	.00
Health status to WPA(T2)	.03	-.20	.25	.00

Notes: B = unstandardized coefficient, β = standardised coefficient; 95% CI is the 95% confidence interval for the unstandardised coefficient; WPA stands for workplace physical activity; T1 and T2 indicate the time of measurement: T1 = Time 1, T1 = Time 2 (16 weeks after baseline). * $p < .05$, ** $p < .001$.

Table 7.18. Path coefficients for the longitudinal model (TOTPA) with background factors (n = 361)

Path	B	B 95% CI		β
Past behaviour to TPB(T0)				
TOTPA(T0) to Attitude(T0)	.01*	.00	.01	.20
TOTPA(T0) to PBC(T0)	.01**	.01	.02	.26
TOTPA(T0) to Subjective norm(T0)	.01*	.00	.01	.16
TOTPA(T0 to Intention(T0)	.00	.00	.00	.02
TPB and future behaviour (baseline-T1)				
Attitude(T0) to Intention(T0)	.07	-.07	.20	.06
PBC(T0) to Intention(T0)	.69**	.52	.86	.78
Subjective norm(T0) to Intention(T0)	.11*	.03	.18	.15
Intention(T0) to TOTPA(T1)	5.51*	1.03	9.99	.20
Behaviour at Time 1 to TPB(T1)				
TOTPA(T1) to Attitude(T1)	.01	.00	.01	.16
TOTPA(T1) to PBC(T1)	.01*	.01	.02	.31
TOTPA(T1) to Subjective norm(T1)	.01*	.00	.02	.22
TOTPA(T1) to Intention(T1)	.00	-.01	.00	-.03
TPB and future behaviour (T1-T2)				
Attitude(T1) to Intention(T1)	.16	-.02	.34	.13
PBC(T1) to Intention(T1)	.69**	.44	.94	.71
Subjective norm(T1) to Intention(T1)	.16*	.04	.28	.16
Intention(T1) to TOTPA(T2)	-.13	-2.88	3.13	.01
Autoregressive paths				
Attitude(T0) to Attitude(T1)	.61**	.43	.79	.64
PBC(T0) to PBC(T1)	.55**	.34	.77	.50
Subjective norm(T0) to SN(T1)	.41*	.08	.80	.45
Intention(T0) to Intention(T1)	.09	-.05	.27	.09
TOTPA(T0) to TOTPA(T1)	.58**	.41	.75	.53
TOTPA(T1) to TOTPA(T2)	.61**	.41	.82	.72
TOTPA(T0) to TOTPA(T2)	.10	-.07	.26	.11
Background factors				
Health status to Attitude(T0)	.25*	.01	.49	.07
Health status to PBC(T0)	-.41*	-.79	-.03	-.10
Health status to TOTPA(T0)	.45**	.25	.64	.26
Age to PBC(T1)	.43**	.23	.63	.21
Age to Intention(T0)	-.02*	-.03	-.01	-.15
Group to ATT(T1)	.01*	.00	.02	.11

Notes: B = unstandardized coefficient, β = standardised coefficient; 95% CI is the 95% confidence interval for the unstandardised coefficient; TOTPA stands for total physical activity; T1 and T2 indicate the time of measurement: T1 = Time 1, T1 = Time 2 (16 weeks after baseline). * p < .05, ** p < .001.

Table 7.19. Total effects for the longitudinal model (TOTPA) with background factors (n = 361)

Effect	B	B 95% CI		b
Attitude(T0) on WPA(T1)	.37	-.46	1.19	.01
PBC(T0) on TOTPA(T1)	3.80*	.67	6.94	.15
SN(T0) on TOTPA(T1)	.62	-.09	1.32	.03
TOTPA(T0) on TOTPA(T1)	.63	.48	.78	.58
Attitude(T1) on TOTPA(T2)	.02	-.46	.50	.00
PBC(T1) on TOTPA(T2)	.09	-1.99	2.17	.00
SN(T1) on TOTPA(T2)	.02	-.46	.50	.00
TOTPA(T0) on TOTPA(T2)	.49**	.34	.63	.53
Group to TOTPA(T2)	-2.81	-11.74	6.12	-.04
Age to TOTPA(T2)	-.01	-.08	.06	.00
Health status to TOTPA(T2)	1.13	-.01	2.26	.03
Gender to TOTPA(T2)	-18.43*	-32.62	-4.25	-.22

Notes: B = unstandardized coefficient, β = standardised coefficient; 95% CI is the 95% confidence interval for the unstandardised coefficient; TOTPA stands for total physical activity; T1 and T2 indicate the time of measurement: T1 = Time 1, T1 = Time 2 (16 weeks after baseline). * p < .05, ** p < .001.

ANNEX B
INTERVIEWS OUTLINE

8.1 Sample Interview Outline for enrolled employees

Opening the interview
Establish rapport. Introduce yourself and your role. Introduce the interview collaborator, if present. Explain to the interviewee that the interview is part of the MoveM8 programme evaluation and will focus on the recruitment and participation in the MoveM8. If the interviewee does not remember the programme, show the MoveM8 logo or probe with further details about the programme. Ask the interviewee if they know the number of employees who successfully enrolled in the programme. If not, tell them, for the record. Advise interviewee that you will be audio-taping the interview and taking notes and at the end of the interview they will have time to ask questions. Interview data and information about the interviewee will be made available only to the research team. Data will be treated as confidential and will not be shared with the employer. When presented on scientific publications, personal data will not be shared. Open the interview by asking the interviewees to introduce themselves and describe their job role. Then ask the following question: What is the first idea that comes to your mind when you see the MoveM8 logo/think about the MoveM8? Let the interviewee think or reflect and talk about this and describe or elaborate the thoughts.
Past experience with health promotion programmes & physical activity
Did you participate in other health promotion programmes before at your workplace? If yes, for what health topics? How were they delivered? Probing: by technology, in person, length, etc. What did you like about those? What did you dislike about those? Is it important to be physically active? If yes, why? If not, why? What is your experience with physical activity?
Reasons for participation in the MoveM8
Why did you enrol in the MoveM8? Probing suggestions: to help increase my PA, because I wanted to lose weight, I was curious about the program, because my colleagues were participants, because my employer promoted it and wanted us to, because it was free, because it was new, etc.
Perceived barriers to participation
Did you experience any difficulties when enrolling in the programme? Probe: technical problems/personal problems/lack of time/survey crashed/survey too long Did you experience any difficulties when participating in the programme? Probe: technical problems/personal problems/lack of time/survey crashed/survey too long Was your organisation supportive? If yes, why/how? If no, why/how? Were your family, friends/colleagues supportive? If yes, why/how? If no, why/how?
Programme evaluation
Did the MoveM8 programme meet your expectations? If yes, how and why? If not, how and why not? Did you like the way the programme was delivered to you? If not, why? Probe: text messaging, email. What did you like about the MoveM8 programme the most? What could have been done better in terms of content and promotion? Would you recommend it to your colleagues? If yes, why? If no, why?
Conclusion/Debrief
Ask the interviewee if they want to add anything. Thank and ask them to and ask if they have further questions about the study.

8.2 Sample Interview Outline for non-enrolled employees

Opening the interview
Establish rapport. Introduce yourself and your role. Introduce the interview collaborator, if present. Explain to the interviewee that the interview is part of the MoveM8 programme evaluation and will focus on the recruitment and participation in the MoveM8. This on the fact that you know they were interested, started to enrol and then quit. Then they also did not respond to another email request asking them to finish enrolment by completing the baseline assessment. If the interviewee does not remember the programme, show the MoveM8 logo or probe with further details about the programme. Advise interviewee that you will be audio-taping the interview and taking notes and at the end of the interview they will have time to ask questions. Interview data and information about the interviewee will be made available only to the research team. Data will be treated as confidential and will not be shared with the employer. When presented on scientific publications, personal data will not be shared. *Ice-breaking questions* Open the interview by asking the interviewees to introduce themselves and describe their job role and work status. Then ask the following question: What is the first idea that comes to your mind when you see the MoveM8 logo/think about the MoveM8? Leave the interviewee think or reflect and talk about this and describe or elaborate the thoughts.
Past experience with health promotion programmes & physical activity
Did you participate in other health promotion programmes before at your workplace? If yes, for what health topics? How were they delivered? Probing: by technology, in person, length, etc. What did you like about those? What did you dislike about those? Is it important to be physically active? If yes, why? If not, why? What is your experience with physical activity?
Reasons for non-participation
Why did you not enrol in the MoveM8? If yes, in what aspects and how were they different from or similar to the MoveM8?
Barriers to participation
What were the major difficulties you encountered while enrolling? Probing suggestions: the way in which it was promoted (flyers, emails)? The program name? The survey was too long, too difficult to use? Was it the communication technology used (emails and text messages)? Was it the time, the workload Was your organisation supportive? If yes, how? If no, how? How did your organisation promote the programme? What did they tell you?
Conclusion/Debrief
Ask the interviewee if they want to add anything. Thank and ask them to and ask if they have further questions about the study.

ANNEX C
SAMPLE E-MAIL MESSAGES

9.1 Sample of message addressing intention

[wk]	WEEK 6
[edate]	WEDNESDAY 28 OCTOBER 2009
[etime]	11.00
[construct]	Intention: making a commitment
[messid]	2.1
[etopic]	Making a commitment.
[e1head]	the land of kept promises
[eintro]	Hi there, [fname], when you signed up for the MoveM8 programme, you agreed that you would try to increase your physical activity over the next 12 weeks. Because you are still here, it means that you clearly know how important physical activity is! That's great! You know, being more physically active implies decisions, goal setting and planning. And you know what really works? Commitment, which is today's keyword.
[ebody]	It's all about commitment. "Making a commitment" is a strategy that worked for millions of people around the globe… We know this seems like common sense, but it really does work. When people commit to doing something (and really mean it), they are setting themselves up for success. Simply by writing down on a piece of paper, "I commit to increasing my physical activity this coming week" gives you a better chance of succeeding. Be specific. What is even better is to commit to something very specific such as "I commit to going for a walk during my lunch hour on 3 days this coming week". Some people find it especially helpful if they tell someone they are committed to increasing their physical activity or getting together with a workout partner Do what works best for you. Make a promise to yourself and feel good about keeping it!
[etip]	Make a promise to yourself to get more activity. Then feel good about keeping it! Ask a friend to remind you of your commitment or post a note in your agenda or next to your computer screen.
[etesti]	John, 45 years old, lawyer. "I've tried many times to become more physically active, but I realized that I was not really committed to do it. I spoke with my son about it and asked him to help me out. I promised him that I would start walking for 40 minutes 3 days a week. He promised to help me out by reminding me of my commitment and even joining me once per week. And guess what? I've been doing it for over a year now! I am proud of myself and feel great!"
[eend]	Next week... we will talk about how setting goals and being SMART. Healthy regards and see you next Wednesday! The MoveM8! team

9.2 Example of message addressing PBC

[wk]	WEEK 8
[edate]	WEDNESDAY 11 NOVEMBER 2009
[etime]	11.00
[construct]	Perceived Behavioral Control: increasing motivation
[messid]	4.2
[etopic]	The ups and downs of motivation
[e1head]	Find the good reason
[eintro]	Dear [fname], for most of us motivation comes and goes. We believe that this happened to you, too: you get tired, life gets busy, excuses pile up, all making it difficult to stay motivated each day. So, all you need to do is to find ways to find the motivation and remind yourself of why you want (your motives) to be more active, because we all know that it is easier to be physically active when we are motivated to do so.
[ebody]	Find reasons to be more physically active. You might already have your personal stimulus toward increasing your physical activity level. Write that down and put it in a place where you can see it often. Tape a note to your computer, stick it on the bathroom mirror, e-mail it to yourself, or ask a friend or family member to remind you each week. If you don't already have a list of motives for being more active, take the next 3 minutes and jot down some thoughts. For some people, the desire to spend more quality time with their families is a strong motivation. Remind yourself that in order to take care of others, you have to care of yourself. For others, it's managing weight or keeping the heart healthy. The possibility of reducing stress is another great source of motivation. If you have a dog, do it them. They need daily activity, just like you! Think about your life long dreams and goals and what it takes to get there. We bet being healthy is part of that. Keep in mind that making time for physical activity is not a selfish act. Your worksite supports you and we bet your family and friends do, too!
[etip]	Make a list of reasons you want to be more active. Be sure to look at your list often, especially if you are not feeling very motivated. Imagine yourself succeeding. Use mental images of you being proud of your accomplishment and feeling good.
[etesti]	This is Sara, 33 years old, Secretary at a University. "I always used to exercise alone because I liked the time to myself. But, on some days I found myself feeling lazy and uninspired. Then a friend of mine invited me to join her and a group of other women for a weekly bicycle ride. I tried it and found that I love the social aspect so much that I rarely miss the ride. Now, I get a few days of activity alone and one with a group of friends. It's perfect for me and keeps me motivated."
[eend]	Next week... we will tell you how to weigh in on weight management. Healthy regards and see you next Wednesday! The MoveM8! team